2008 Final Report Template

FSWP File Number*	FSWP 09 39

*Please use the FSWP File Number provided in previous FSWP 2008 project correspondence

Contact Information

Sponsoring Organization's Legal Name

Lillooet Tribal Council

Are you a federally registered Charity, Non-profit organization or Business (Yes /No)?						YES
If yes, please indicate which.		Charity	X	Non-profit organization		Business
Registration number				GST number		
Are you a registered Society (Yes / No)?				Society Registration number		

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Project Information

Project Title					
Gates Creek Spawning Habitat Improvement					
Project Location					
D'Arcy, BC					
Amount Requested	$76,650	**Total Project Value**	$151,650	**Non-FSWP funds[2]**	$95,000

[2] Non-FSWP funds include both cash and in-kind funding. In-kind funding refers to all non-cash contributions such as equipment, supplies, labour, etc. Please refer to Budget Section for further details.

Project Summary

Please provide a single paragraph describing your project, its objective, and the results. As this summary will be used in program communications, clearly state the issue addressed and avoid overly technical descriptions. Do not use more than 300 words.

Gates Creek supports important summer sockeye and interior coho salmon stocks, both of which are declining due to poor marine conditions and impaired freshwater productivity. This stream is also spawning and rearing habitat for Bull and rainbow trout residing in Anderson Lake. The watershed partners have identified three key factors in declining salmon productivity: deterioration of the quality of the spawning gravel within the Gates Creek spawning channel, poor access for returning spawners to upper Gates Creek spawning grounds due to an in stream weir associated with the channel, and an inability to manage spawners at the counting fence in the stream such that adequate spawners can access both channel and river spawning grounds upstream. Consequently, this FSWP project was undertaken to:

- Construct rock riffles just downstream of a concrete weir that presently impedes upstream migrating salmon.
- Add spawning gravels to the Gates Creek spawning channel.
- Construct improved counting and diversion facilities

The rock riffles were deposited downstream of a weir structure in Gates Creek and were observed to facilitate salmon passage at low – medium flow levels. The riffles will be observed under high discharge conditions when coho are migrating upstream. If necessary, adjustments to the boulder positioning will be made and additional stockpiled boulders will be added to the Creek next spring.

In conjunction with BCRP, the gravel at the Gates Creek spawning channel was replaced and the facility has been rejuvenated with appropriately sized sockeye gravel. This will lead to improved egg:fry survival and an overall increase in Gates sockeye production.

Due to budgetary constraints, it was only possible to initiate the improvement of fish sorting and counting facilities via site visits and discussion with SEP personnel. This component of the work will be proposed for FSWP funding in 2010-2011.

OPTIONAL **If your project lends itself to sparking interest through a compelling sound bite (for potential use in FSWP media communications), please tell us what that sound bite would be. Do not use more than 150 words.**

Species and life stage(s) the project targets: please list
Gates Spawning Channel: sockeye eggs and alevins Gates Weir: coho, sockeye, bull trout, rainbow trout

Watershed(s) the project targets: please list
Seton-Anderson

Project Deliverables and Results

- **Paste in the deliverables outlined in your Detailed Proposal (question #3 under project 'relevance and significance' heading) into the table below. Then, please list the results associated with each deliverable.**
- **Please include copies of any relevant communications products (brochures, posters, videos, website addresses etc.) resulting from this project.**

Deliverable	Result
800 meters of improved spawning habitat in Gates Creek spawning channel.	**completed**
Improved adult salmon and trout access to 20 kilometers of stream habitat.	**completed**
Improved enumeration facilities for counting both adult and juvenile salmon in Gates Creek and channel.	**deferred until 2010-2011**
Improved relationships among the partners working together on this important project.	**completed**
Improved capacity within the local community to better manage local stocks of salmon.	**completed**

Project Effectiveness

Please evaluate the effectiveness of the project, using the objective standards, quantifiable criteria and/or quality control measures identified in your Detailed Proposal (under question #1 in the 'performance expectations' heading).

The project was very successful in completing some challenging engineering tasks in an effective manner. Part of the project success reflected the ability to access suitable rock sources, at no cost to the project, in reasonably close proximity to Gates Creek. This included a rounded gravel source that was donated by BC Hydro, and large boulders which originated in a non-functional, isolated reach of the Birkenhead River. There was a strong partnership between N'Quatqua, Northern St'at'imc Fisheries and DFO and good working relationships.

What are the top three lessons learned from this project that would be important to communicate to others doing similar work throughout the Basin?

1. Most important consideration is access to rock and gravel of appropriate dimensions in sufficient quantities.
2. Be sure to engage experienced engineers and biologists – the work is "routine" but would be challenging to carry out from scratch.
3. DFO's participation as an active partner is critical.

Project Effectiveness

Please describe how your project has addressed each Priority Activity identified in your Detailed Proposal.

Priority Activity[1]	How the Priority Activity has been Addressed
This classification was not used for 2009 applications	

[1]Please paste each priority activity identified in your Detailed Proposal in the space provided.

Further Comments

Please provide any further comments including recommendations for future conservation efforts and suggestions for helping partners to meet the goals of the Fraser Salmon and Watersheds Program. If your project produced a narrative or scientific report or additional project products (e.g. maps, photos), attach them as an appendix.

Submission Instructions

Please send your Final Report electronically to your designated FSWP Staff Contact. If you are uncertain who this person is or how to contact them, please contact Tiffany Pither, FSWP Administrator.
Email: tpither@psf.ca
Phone: (604) 664-7664 Ext 119

8) Appendix (Attach reports, maps, photos, etc if applicable)

Gates Creek Spawning Habitat Improvement Project: Technical Report

Prepared for:

Fraser Salmon and Watersheds Program

Introduction

This report provides additional technical information for FSWP Project 09 39. The main objectives of the project were:

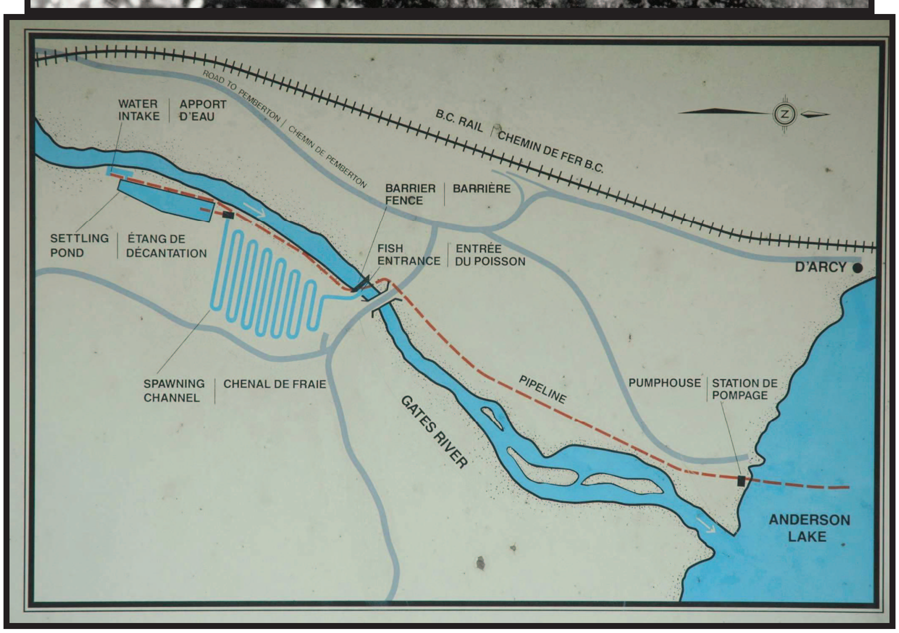
- Construct rock riffles just downstream of a concrete weir that presently impedes upstream migrating salmon.
- Add spawning gravels to the Gates Creek spawning channel.
- Construct improved counting and diversion facilities

As discussed in the main body of the final report, all of the 2009-2010 funding was required to complete the first 2 objectives. Work to complete objective 3 will be proposed for FSWP funding and scheduled for 2010-2011.

Section 1 of this report contains a description of the spawning channel rejuvenation component. A brief description of the weir project is provided in Section 2. Lastly, a literature review of Gates Creek salmon ecology is provided in Section 3.

Section 1: Gates Creek Spawning Channel Improvement

The Gates Creek spawning channel, originally constructed by the International Pacific Salmon Fisheries Commission (IPSFC) in 1968, is a key fisheries enhancement facility in the Seton/Anderson drainage system. The fish produced at this facility contribute to numerous fisheries including the traditional St'at'imc fishery. This project was undertaken to revitalize the Gates Creek Spawning Channel so as to enhance production of sockeye salmon. The project was initiated in 2008 with BCRP support and completed in 2009 with joint FSWP and BCRP support.



During 2009 Northern St’at’imc Fisheries collaborated with Fisheries and Oceans Canada and the N’Quatqua community to complete the gravel replacement project. Existing boulders in the channel and large cobble substrates were removed from the channel and replaced with more suitably sized spawning gravel. During 2009, approximately 1000 m^3 of cobble and boulders was replaced with 1700 m^3 of graded gravel. Channel slope was also increased in the treated section resulting in increased water velocities. Approximately 54% of the channel was treated and rejuvenated in 2009, completing the channel upgrading project. Increased egg-to-fry survival associated with the improved gravel composition is predicted to stimulate future sockeye production starting in 2012.

Treated gravel bed (upper) and large cobble substrates (bottom) that were removed from the channel.

The gravel replacement procedures are illustrated in the photos below. Large boulders and cobbles were removed by means of a small excavator and stock-piled on site for future in-stream work contemplated by NSF and DFO. Following large boulder removal, the gravel bed was cleaned and drained. A source of new gravel was located at Fee Creek beneath the BC Hydro right-of-way and was donated to the project by BC Hydro. The gravel was screened at source and transported to the channel by dump truck where it was stock-piled. A small excavator and a backhoe were used to deposit the new replacement gravel onto the cleaned bed. Once the new gravels were positioned, the channel was flushed and effluent was diverted to a pond to trap the sediments associated with the new gravel. Activities were scheduled during a mid-July through early-August timing window when neither adults nor eggs/juveniles were physically present.

Methods utilized during the Gates Creek spawning channel gravel replacement project.

Section 2: Gates Weir Improvements

While undertaking the channel revitalization project in 2008, it was found that the weir adjacent to the water intake required some emergency machine work in order to buttress the rock footings. There were concerns that the weir and its fish ladder were impeding upstream fish migrations under high and low flows. A small bypass channel was opened around the weir during the sockeye migration to permit upstream fish passage. However, the bypass ceases to function at low flows and there was a question whether other fish species, e.g. coho, can bypass the weir at all flow levels. The improvement of this weir was viewed as a high priority for conserving the threatened interior coho population of Gates Creek. Northern St'at'imc Fisheries and Fisheries and Oceans Canada undertook the weir improvement project in 2009-10 with funding provided by the Fraser Salmon and Watersheds Program. Together with the Gates Spawning Channel revitalization project, the efforts will greatly benefit Gates Creek salmon populations in future and help to partially mitigate some of the BC Hydro footprint impacts in the Bridge-Seton Watershed. Photos illustrating the project are shown below.

Upper left – weir with deposited boulders downstream
Upper right – stock-piled boulders for future use to fine tune the rock riffles
Lower left – weir under mid-level flow conditions
Lower right – existing fish counting fence on Gates Creek

Section 3: Review of Gates Creek Salmon Ecology

Review of Salmon Ecology in the Gates Creek Watershed

September, 2009

This report was prepared with the support of the BC Hydro Bridge Coastal Fish and Wildlife Restoration Program and the Fraser Salmon and Watersheds Program

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Introduction

Gates Creek flows into the head of Anderson Lake adjacent to the community of D'Arcy (Figure 1). It is the single most important salmon tributary within Northern St'at'imc Territory supporting a major sockeye run and a sizable coho population, along with bull trout and rainbow trout. Since 2006, Northern St'at'imc Fisheries (NSF) has been working cooperatively with DFO, BC Hydro and provincial agencies to restore the salmon productivity of Gates Creek. During 2008, with funding provided by BCRP, about half of the gravel was replaced in the sockeye spawning channel and this work was completed in 2009. Also in 2009, NSF was funded by the Fraser Salmon and Watersheds Program (FSWP) to rebuild fish passage facilities in Gates Creek adjacent to the spawning channel water intake.

Salmon from Gates Creek face a gauntlet of impacts associated with BC Hydro's Seton power generating facilities. As migratory smolts, the salmon encounter the Seton Dam and can be entrained into the generator which causes significant mortality. This mortality is presently being mitigated via 6-h nightly generator shutdowns during peak smolt migration periods. As adults, salmon can delay their migration due to attraction to the powerhouse tailrace waters. Investigators have also shown that adult salmon experience difficulties finding the fish ladder entry, and that this can cause significant mortality.

In view of the importance of Gates Creek for St'at'imc fish production, this review paper has been prepared to summarize the available information on salmon ecology of the Gates Creek watershed, including Anderson Lake.

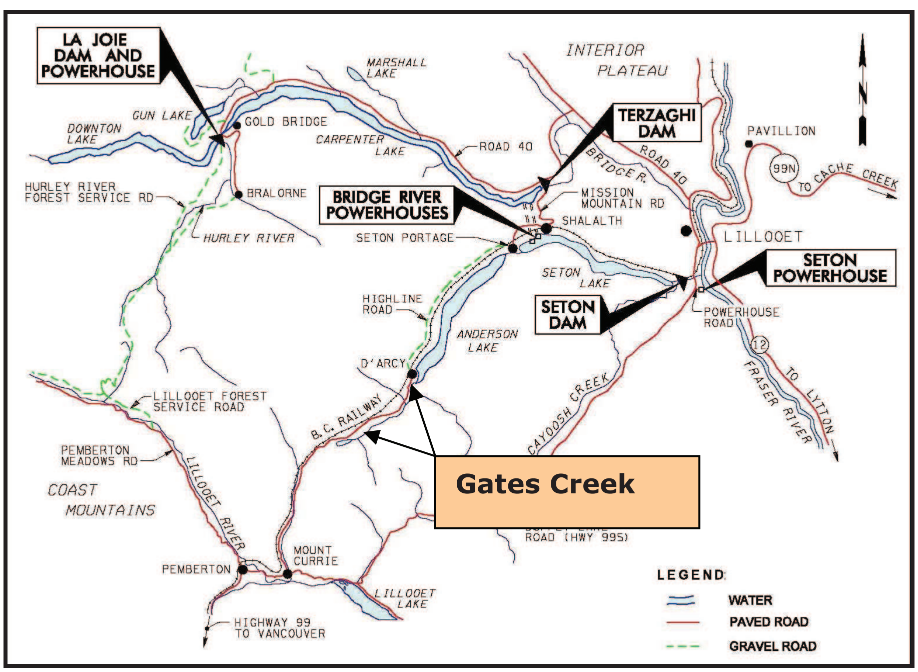

Figure 1. Location of Gates Creek.

Previous Fish Surveys

Matthew and Stewart (1987)

The following description of Gates Creek was derived from Matthew and Stewart (1987). During their investigations, Gates Creek was divided into 10 reaches based on gradient and habitat character (Figure 2). Total stream length of Gates Creek is 15 km of which 14 km has potential anadromous use. Habitat parameters are shown in Table 1.

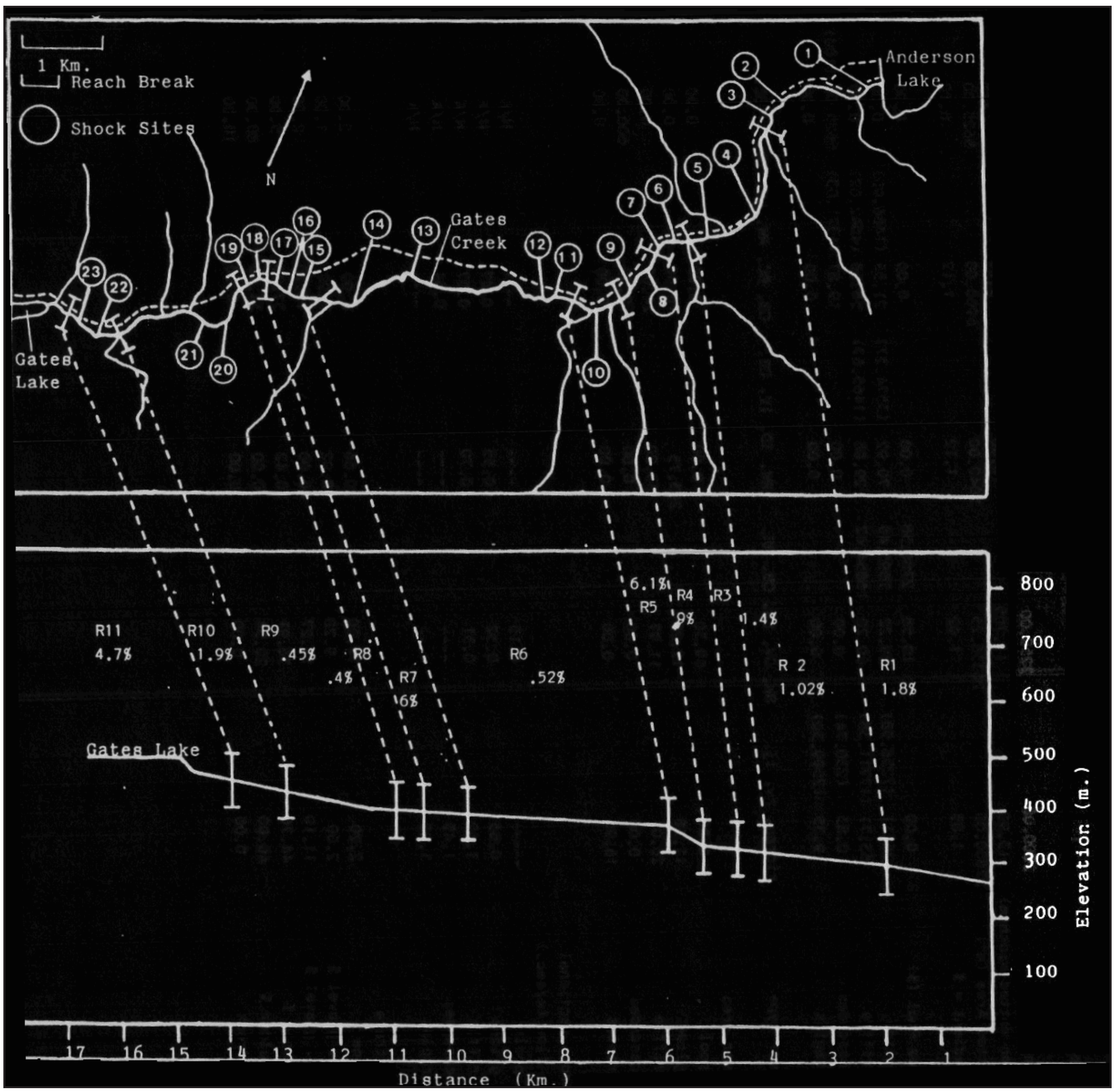

Figure 2. Location of fish sampling reaches (R1-R11, below) and 23 electroshocking sites (above) adopted by Matthew and Stewart (1987).

Reach 1 with a gradient of 1.85% extends 2 km upstream of Anderson Lake to the railway crossing. This reach consists mainly of long riffles (64%) and glides

(26%) with occasional rapids and cascades. Boulders and cobble predominate throughout, however, significant amounts of gravel provide provide spawning habitat 220 m upstream of Anderson Lake. The majority of Reach 1 has been channelized by BC Railway. Rip-rap utilized to stabilize banks provides significant refuge area throughout most of the reach. High velocities (increased by channelization) limit usable habitat to extreme edge areas. Rootwads and logjams are generally associated with glide habitats.

Reach 2 with a gradient of 1.02% is characterized by long riffles (60%) and short deep glides (29%). Pools formed by logjams provide an abundance of refuge area for juvenile salmonids. Cutbank and rootwad cover is generally associated with glide and riffle habitats. High velocities in most riffle and glide habitats limit usable rearing area considerably. Velocity in pools however is expectedly low. Substrate is generally larger consisting of boulders (21%), cobble (39%), and large/small gravel (17%). Small gravels and fines are associated with pool habitats.

Reach 3 is a short meandering section (500 m) consisting of long deep glides broken by short riffles. Fines and small gravel predominate; a combination of large gravel and cobble provide excellent spawning habitat in some areas. Gradient measures 1.4%. Instream debris provides abundant cover in most glide habitats and effectively reduces velocity to habitable levels for juvenile salmonids. This effect is not apparent in most riffle habitats where rearing area is limited to cutbanks.

Reach 4 (750 m) is a relatively low gradient (0.9%) section confined by bedrock and clay banks. Long fast riffles (59%) and short cascades (20%) predominate. Glides are generally associated with logjams. High velocities limit rearing area in most glides and riffles. Substrate mainly consists of large boulder and cobble. Suitable spawning gravel is limited.

Reach 5 (750 m) with the highest gradient (6.1%) consists mainly of cascades confined by low steep banks. Extremely high velocities limit rearing to cutbank and boulder edge areas. Large boulders and bedrock substrate provide cover. Rearing area usable by juvenile salmonids is minimal throughout this section. One large logjam creates annual migration problems for adult coho.

Reach 6 (3.75 km) is a relatively long meandering low gradient (0.52%) section characterized by long deep low velocity glides (96%) broken by short riffles. This section, covered by dense underbrush and Cottonwood forest, is generally inaccessible. Instream debris and streamside vegetation provide excellent cover. Fines and small gravel predominate. Side channels provide additional rearing area.

Table 1. Fish habitat characteristics of Gates Creek (Matthew and Stewart 1987).

Reach	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Length (m)	2000	2250	500	750	750	3750	750	500	2000	1000
Mean Wetted Width (m)	13.9	11.7	10.1	9.2	7.5	9.75	11.4	9.0	6.1	75.4
Wetted Area (m^2)	27800	26336	5040	6900	5625	36,600	8280	4490	12140	75360
Gradient (%)	1.85	1.02	1.12	1.12	6.1	0.52	0.6	0.4	1.45	1.9
Area (%)										
pool	0	10.6	0	0	0	2.6	0	0	0	5.5
glide	26.1	29.2	70.9	21.6	0	96.1	80.6	52.7	28.6	32.9
riffle	63.7	60.2	29.1	58.6	0	1.4	19.4	47.3	47.3	61.6
cascades	0.8	0	0	19.9	100	0	0	0	0	0
rapids	9.4	0	0	0	0	0	0	0	0	0
Flow (m/sec)										
pool	-	0.15	-	-	n/a	0.11	-	-	-	0.83
glide	0.65	0.32	0.55	0.47	n/a	0.23	0.43	0.54	0.07	2.3
riffle	1.62	0.51	0.7	0.57	n/a	0.61	0.33	1.05	1.2	3.1
cascades	1.49	-	-	0.54	n/a	-	-	-	-	-
rapids	1.22	-	-	-	n/a	-	-	-	-	-
Substrate (%)										
fine	2.2	14	20.7	6.9	2	83.5	80	22.9	10.9	18
small gravel	2	9.3	18.9	7.9	1	10.1	10	34.6	14.6	22
large gravel	11.1	17.3	40	13.7	2	4.9	7	37.9	30.8	33
cobble	44.7	38.9	20.4	37.5	5	1.1	2	4.6	39.6	22
boulder	40	20.5	0	34	80	0.5	1	0	4.1	5
bedrock	0	0	0	0	10	0	0	0	0	0

Reach 7 (750 m) consists mainly of long glides and short shallow riffles over fines and small gravel. Overstream vegetation abd debris jams provide most of the cover. Natural coho spawning areas throughout this section are concentrated where extensive canopy cover exists. High main channel water velocities limit juvenile salmonid rearing to sidechannels and edge habitats.

Reach 8 (500 m) a short low gradient (0.4%) section is confined by high clay banks. High velocities limit usable rearing area to debris jams and cutbanks. Substrate in the reach is fairly compact. Clay and silt deposits combined with large gravel limit available coho spawning habitats=.

Reach 9 (2 km) with moderate gradient (1.45%) is characterized by high velocity riffles and short deep glides generally formed by debris jams; cobble and large gravel substrates predominate. Pockets of small gravel scattered throughout the reach provide limited spawning area. Usable rearing area for juvenile salmonids is limited to cutbank/rootwad combinations.

Reach 10 (1 km) consists of long shallow riffles and glides over mainly gravel and cobble substrates. High velocities attributable to a slight increase in gradient (1.9%) limit juvenile salmonid rearing to glide habitats with instream debris cover.

A relatively steep (4.7%) 1 km section extending from Reach 10 to Gates Lake provides minimal rearing habitat usable by juvenile salmonids. This area flowing through dense underbrush and cedar forest offiers little spawning habitat.

In Gates Creek the majority of usable rearing habitat is found in Reaches 3 and 6 where glides with relatively low velocities and an abundance of instream cover exists. Fast main channel velocities generally limit juvenile salmonid rearing habitat to extreme edge areas in most reaches. Spawning habitat preferred by coho salmon (moderate velocities, small gravel and instream cover) is mainly found in Reaches 3 and 7.

D'Arcy Springs is an important fish habitat located near the northeast end of Anderson Lake (Figure 3). It consists of an upwelling spring that flows through a 75 m channel into a large marsh. The channel section is characterized uniform riffles and glides while the marsh area consists mainly of beaver ponds and a complexity of sub-channels. The flow (1.13 m^3/sec in June) from the springs is relatively constant throughout the year. Gradient is low at 0.04%. The area of the springs, channel and marsh totaled 6230 m^2 with a mean depth of 0.3 m. Instream debris and vegetation formed 1435 m^2 of cover or 23% of the total swamp area. Silt and fines were found in the marsh while small gravel provide excellent spawning habitat in the channel. In general, D'Arcy Springs with excellent cover and low velocities appears to provide a stable rearing environment for anadromous salmonids.

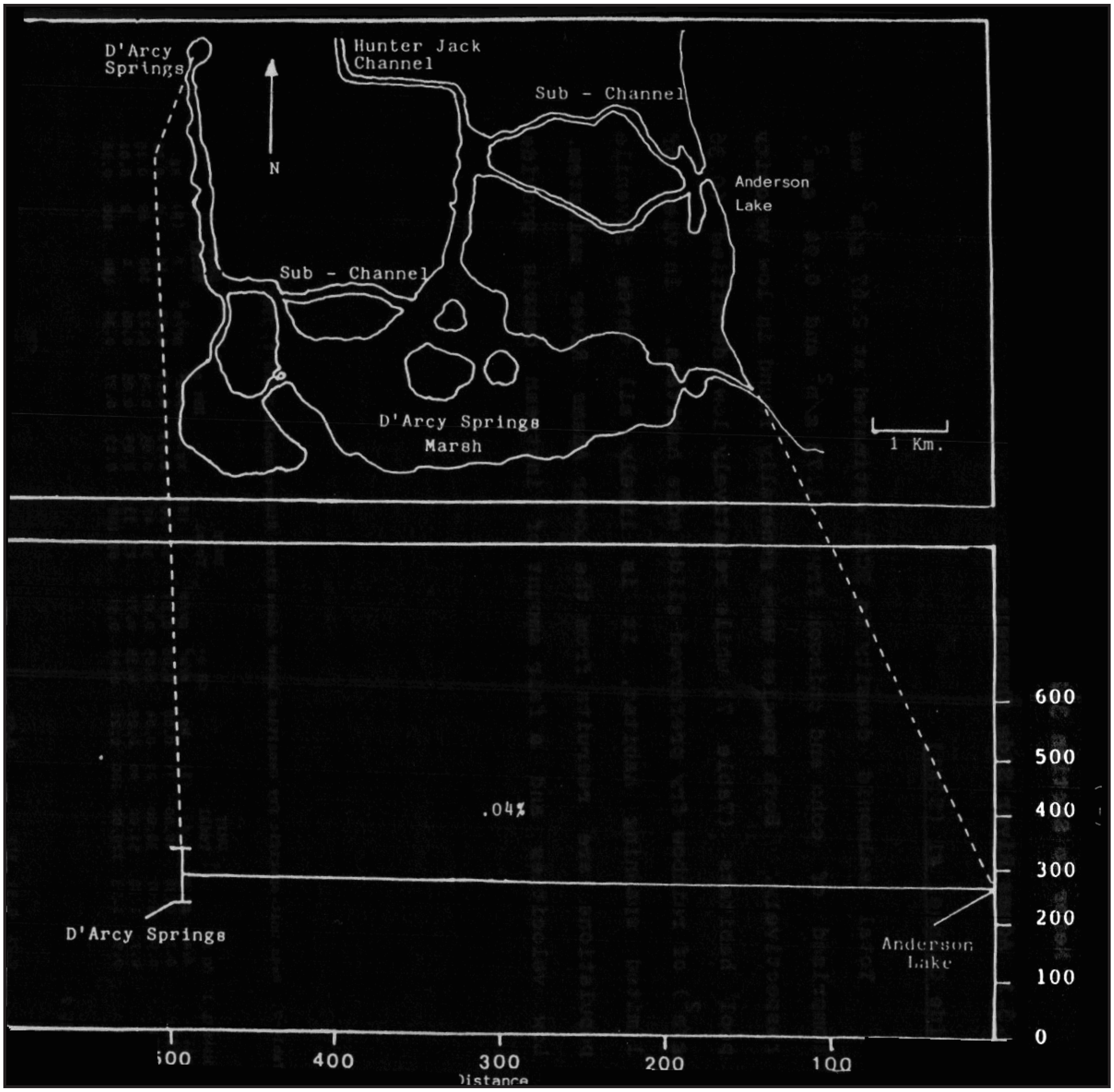

Figure 3. Sketch of D'Arcy Springs adjacent to Anderson Lake.

Fish populations in Gates Creek consisted of coho, rainbow trout and Dolly Varden[2]. In Reach 1, total salmonid density was 3.01 g/m^2. The highest mean densities of coho and rainbow fry were found in glide habitats. Dolly Varden fry preferred riffles. Relatively high water velocities limit rearing to extreme edges, generally rip rap or large instream boulders.

Total densities for both coho and rainbow fry in Reach 2 were very low at 0.06 g/m^2. Yearling rainbow density was also low totaling 0.97 g/m^2. In Reach 3 low densities of coho fry were found only in glide habitats. Rainbow fry were found only in riffles. Total density of yearling rainbow was low. High velocities in Reach 3 limited rearing to edge areas. Total salmonid density was 0.87 g/m^2.

[2] Most likely bull trout

Similar conditions were observed in Reach 4. Velocities were relatively high. Total salmonid density was higher at 2.87 g/m^2. Coho fry density slightly higher than in Reaches 1-3, was low at 0.32 g/m^2. Total density of yearling rainbow was substantially higher (2.42 g/m^2).

In Reach 5 (cascades) rainbow fry were the only species found (0.08g/m^2).

Total salmonid densities in Reach 6 were high at 5.86 g/m^2. Relatively high coho fry densities (3.88 g/m^2) can be attributed to excellent rearing conditions, low velocities and extensive instream debris cover. The highest coho densities were found in glide habitats where the total stream width is usable. Rainbow trout densities totaled 1.2 g/m^2 with the highest mean densities obtained in riffle units. Low densities of Dolly Varden fry (0.06 g/m^2) were found in glide habitats while yearling densities of the same species were higher at 3.3 g/m^2.

In Reaches 7-10 fish populations consisted of rainbow trout and Dolly Varden. Sporadic coho spawning occurs throughout Reach 7 and 8 however no coho fry were obtained during sampling. Coho fry probably move down to Reach 6 where good rearing habitat exists. Total rainbow fry densities averaged 1.3 g/m^2 while the average total density of yearling rainbow was 1.7 g/m^2 in Reaches 7-10. Dolly Varden fry found only in Reach 8 existed at a density of 1.1 g/m^2.

Relatively high coho fry densities were obtained in Reaches 1 and 6. With limited available rearing area and high water velocity, habitat for coho in Reach 1 may currently be near potential production levels at 1.9 g/m^2. Estimates of coho fry densities in Reach 3 are considered low as deep glides with excellent cover were inaccessible to electroshocking in the lower 250 m section. High quality rearing habitat coupled with relatively low total coho fry densities (3.9 g/m^2) suggest that Reach 6 may be presently underutilized. Rainbow fry densities were highest in Reaches 6-10 averaging 1.26 g/m^2. Yearling rainbow were found in moderate densities in Reaches 4 and 10 (2.4 g/m^2 and 2.8g/m^2 respectively.

In general, coho production potential is limited by high water velocities in all reaches with the exception of Reaches 3 and 6 where velocities are relatively low and abundant cover exists.

Fish populations at D’Arcy Springs consist of coho fry and yearling rainbow trout. Total coho fry densities at 6.2 g/m^2 were comparable to other fairly productive interior BC coho streams. Yearling rainbow trout density was low at 0.42 g/m^2. The total coho fry population was estimated at 12,081 fry (38.01 kg) while yearling rainbow totaled 560 (2.6 g). In general habitats are excellent for rearing coho at D’Arcy Springs. Excellent cover and low velocities allow coho production in 100% of the stream area.

Gates Creek Coho Enumeration

The DFO sockeye spawning channel diversion fence located approximately 1 km upstream of Anderson Lake was modified to enumerate adult coho at Gates Creek. The fence normally utilized to divert sockeye into Gates Creek spawning channel was opened during September allowing sockeye to migrate to the upper spawning areas in Gates Creek. An unknown number of coho may have escaped into Gates Creek uncounted prior to fence installation. Fence operation began Sept. 30 with a capture of 41 coho. Initial coho immigration probably began in late September. Figure 4 illustrates daily catches at the Gates Creek fence.

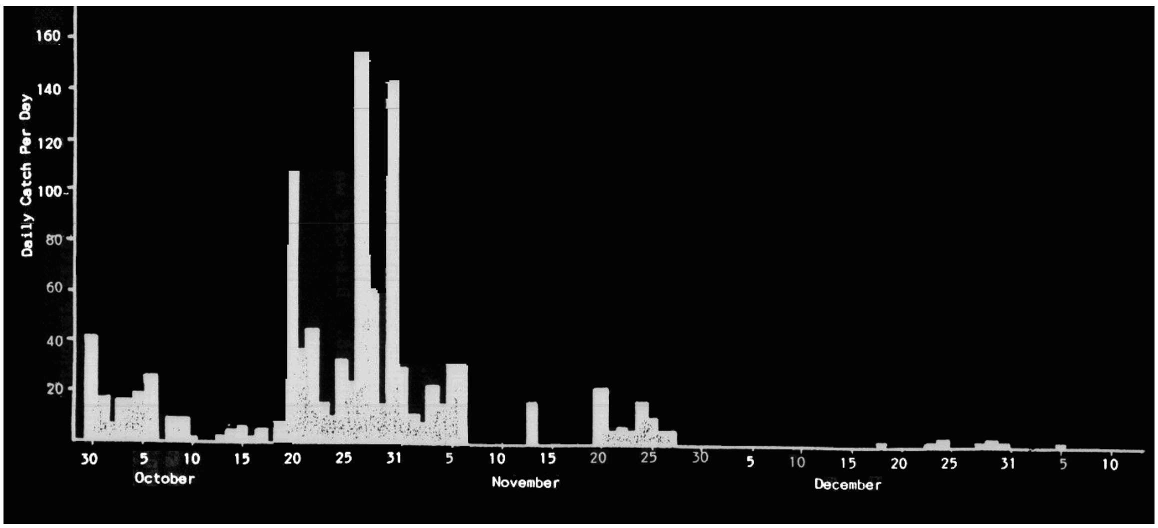

Figure 4. Daily fence catches of coho in Gates Creek, 1986.

Gilling proved to be a problem at Gates Creek. Smaller than average-sized coho attempting to swim between fence panel bars were gilled, resulting in a total of 41 coho (30 males and 11 females) mortalities. A total of 1029 coho (543 males and 486 females) were passed live over the fence. The fence total plus a number enumerated downstream of the fence to Anderson Lake resulted in an estimated escapement of 1205 coho to Gates Creek. Brown *et al.* (1979) reports escapements ranging between 400 – 1500 coho from 1970 -1978. The most recent escapement by Jarvis and Stewart (1985) estimated 534 coho.

For comparative purposes the 1986 Gates Creek coho escapement upstream of the Gates Creek fence was estimated by utilizing a single census mark and recovery program. Tags were applied to 453 coho from October 08 to December 29 from fence captures. A total of 277 carcasses were examined and 90 tags were recovered for a 20% tag recovery rate. The population by mark and recovery for Gates Creek was 1387. Since some coho may have passed by the fence uncounted prior to September 30 this estimate may be close to the actual coho escapement upstream of the fence. Adding the estimated 1387 coho above the fence (mark and recovery) and 167 coho counted downstream of the fence to Anderson Lake gives a total escapement of 1554 coho to Gates Creek. Considering the low tag recovery rate and the incidence of live fish removal upstream of the fish fence (poaching and predation) this estimate may be slightly high.

The temporal aspects of the 1986 coho reproduction are summarized below:

	Initiation	**Peak**	**Termination**
Immigration	Mid-September	Late October	Late December
Spawning	November 05	Mid-November	December 30
Die-off	November 05	November 28	Early January

Escapement estimates by fence count, Petersen disc tag recovery and stream survey are summarized below:

	Fence count	Petersen estimate	Stream survey
U/S fence	1029	1387	374
D/S fence (stream survey)	176	176	176
Total escapement estimate	1205	1563	550

Coho spawning activity was heavy in the lower 200 m of Reach 1 and in Reach 3 (Figure 5). Moderate spawning activity was recorded in Reaches 7 and 8.

A male to female sex ratio of 1.1:1 was derived from fence data. A total of 277 carcasses were recovered during 1986 field studies. Age data was obtained on 80 carcasses. The 3_2 age class proved to be dominant comprising 57% of the sampled. The age class 4_3 accounted for 8% of the sample. Of all fish sampled, 33% had resorbed scales.

D'Arcy Springs upwells and flows 0.5 km into the northeast end of Anderson Lake. The majority of spawning activity occurs in a 75 m channel section immediately downstream of D'Arcy Springs (Figure 6). Spawning is scattered throughout the remaining 425 m to Anderson Lake. The temporal aspects of coho reproduction are summarized below:

	Initiation	**Peak**	**Termination**
Immigration	Late October	Mid-November	Mid-December
Spawning	Early November	November 20	January 06
Die-off	November 10	November 28	January 07

The population estimate of 166 coho was considered a reasonable estimate of the 1986 D'Arcy Springs escapement. The peak stream count on November 20 totalled 111 coho (92 live + 19 carcasses to that dates). A total of 147 carcasses were eventually recorded.

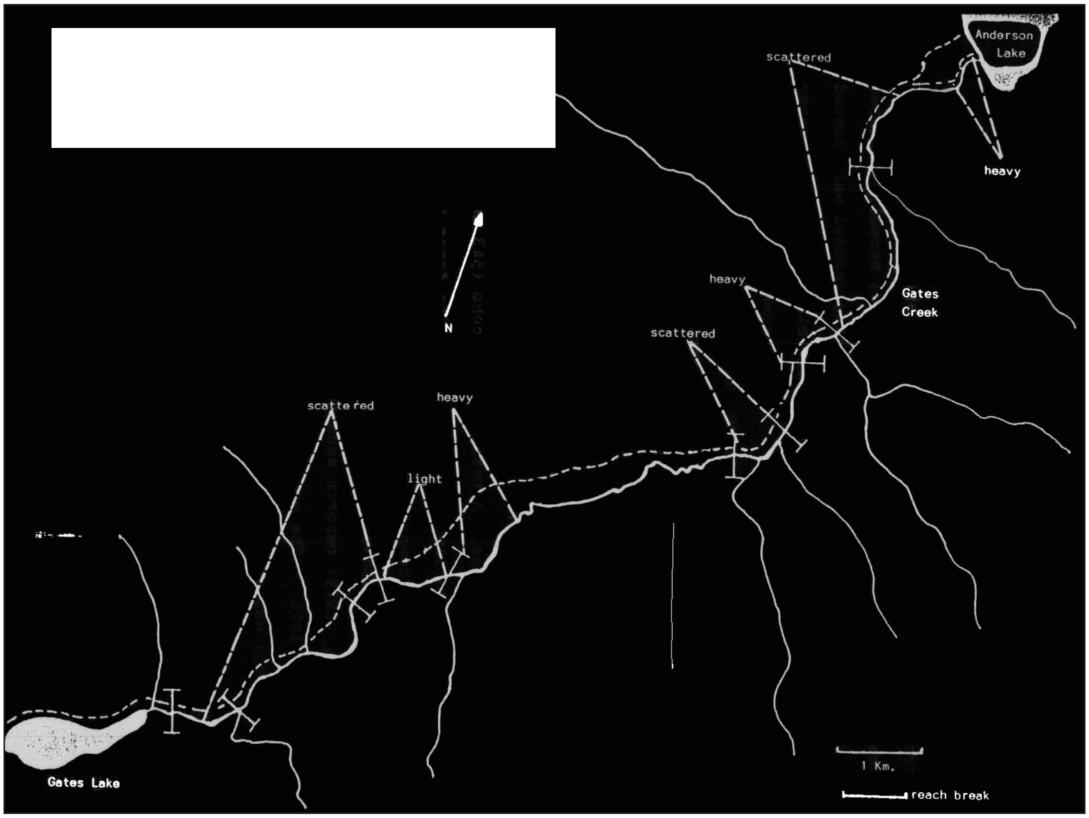

Figure 5. Distribution of Gates Creek coho reproduction, 1986.

Figure 6. Distribution of D'Arcy Springs coho reproduction, 1986.

Creekside Resources (2001)

A survey was carried out in Gates Creek by Creekside Resources in the fall of 2000 to address the following:

- large log jam assessment and removal if necessary
- determine salmonid utilization of entire watershed
- identify potential barriers to upstream migration
- identify threats to fish species
- recognize limiting factors to fish populations
- assess current habitat conditions
- identify restoration opportunities

The creek was divided into 9 main reach breaks and habitat characteristics were surveyed. The total length of the watershed study area was 1.74 km. Fish were sampled by minnow traps and the following species of juvenile fish were recorded:

- coho
- Chinook
- Dolly Varden[3]
- rainbow trout
- sculpin

The study concluded:

- system has a consistent freshwater supply for fish and community
- spawning salmonids are present and utilizing the watershed
- beaver dams are providing rearing habitats for parr and fry, and holding for adults
- upper reaches contain sufficient forest canopy
- available substrate is sufficient for rearing and spawning
- grasses, shrubs and willows provide the dominant riparian structure in the lower reaches
- water temperature is consistent and visibility is clear
- large wood debris provides valuable habitat structure

[3] Most likely bull trout

Thevarge (2004)

This BCRP project was undertaken in Gates Creek in 2003 to address the following objectives:

1. Installation of one kilometer of livestock exclusion fencing with watering points for bison at the Gates Creek Bison Ranch.
2. Assessment of fish passage concerns and evaluation of off-channel juvenile fish rearing habitat sites.
3. Juvenile fish trapping (presence/absence) in the Gates Creek Watershed

The photo below illustrates the fencing that was positioned 5m from the stream bank. N'Quatqua community members installed the fence in cooperation with the landowner. Benefits of the project include better conditions for tree and shrub growth thereby protecting water quality, providing cover for fish and adding stability to stream banks.

Several additional fencing sites were identified. They included additional fencing at the Gates Creek Bison Ranch and other ranches along Gates Creek.

There was evidence of erosion at the Indian Beach site (Figure 7). It was recommended that planting be undertaken adjacent to the stream banks as the area is highly mobile due to its proximity to the lake. Recommended species included willows due to their tolerance of high water table and their extensive and fast growing root system.

An area of potential off-channel habitat (Figure 7) was identified, but at the time, local landowners did not support this project.

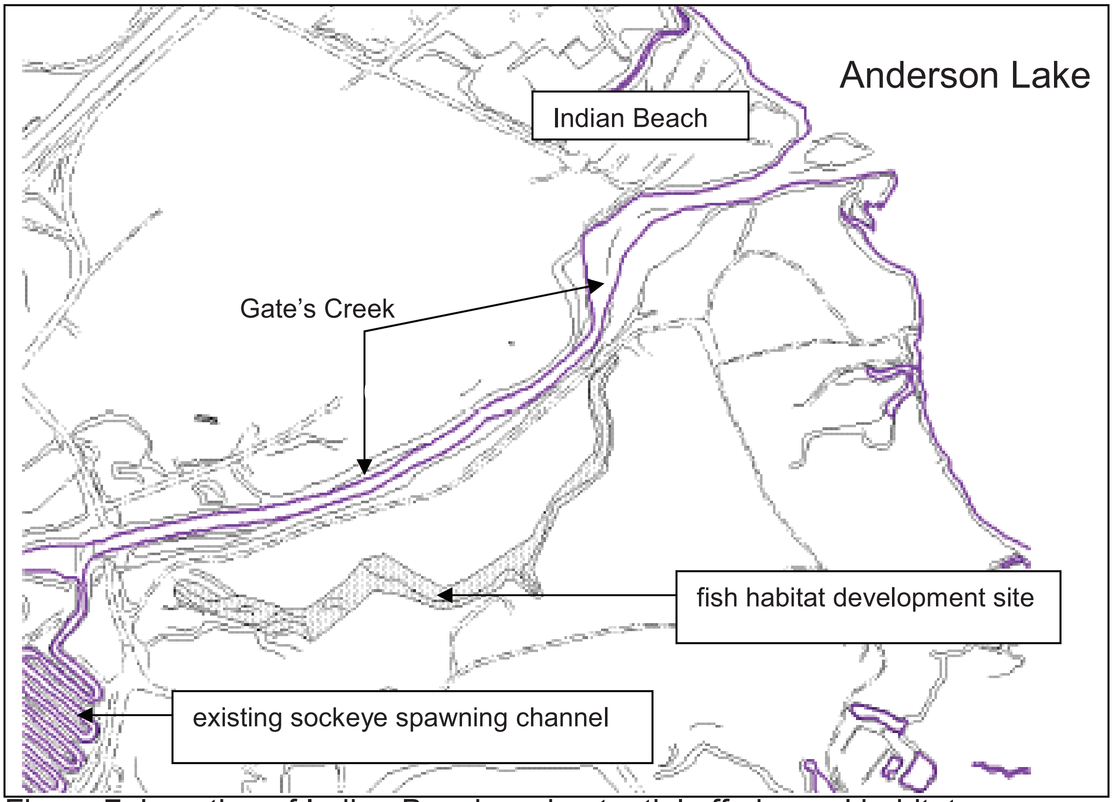

Figure 7. Location of Indian Beach and potential off-channel habitat.

The bridge adjacent to the spawning channel on Gates Creek was identified as a migratory obstacle for fish passage. Although the structure is passable to most adult fish, improvements could be made to reduce their energy expenditure as they migrate upstream. The boulders between the Gates Creek Spawning Channel outlet and the bridge are on a steep slope. This creates torrent rapids that hinder fish passage up stream. A suggested prescription to address the passage concerns at the site was to construct a series of rock weirs (Figure 8). The weirs would be constructed approximately 60 meters apart and each would have an elevation change of approximately 1 meter. The weirs would backwater the existing boulder cascade. The size of rock required is 1 m diameter minimum. Over 1200 cubic metres of rock would be required to construct the three structures.

The third component of the study measured fish presence/absence using Gee minnow traps. A total of 8 sites were sampled over the period September '03 to February '04. Sampling sites are shown on Figure 9. There was a total of five different species trapped throughout the Gates Creek Watershed, which included bull trout (*Salvelinus confluentus*), Dolly Varden (*S. malma*), rainbow trout (*Oncorhynchus mykiss*), coho (*O.s kisutch*) and sculpins (*Cottus sp.*). Catch results are shown in Figures 10-12.

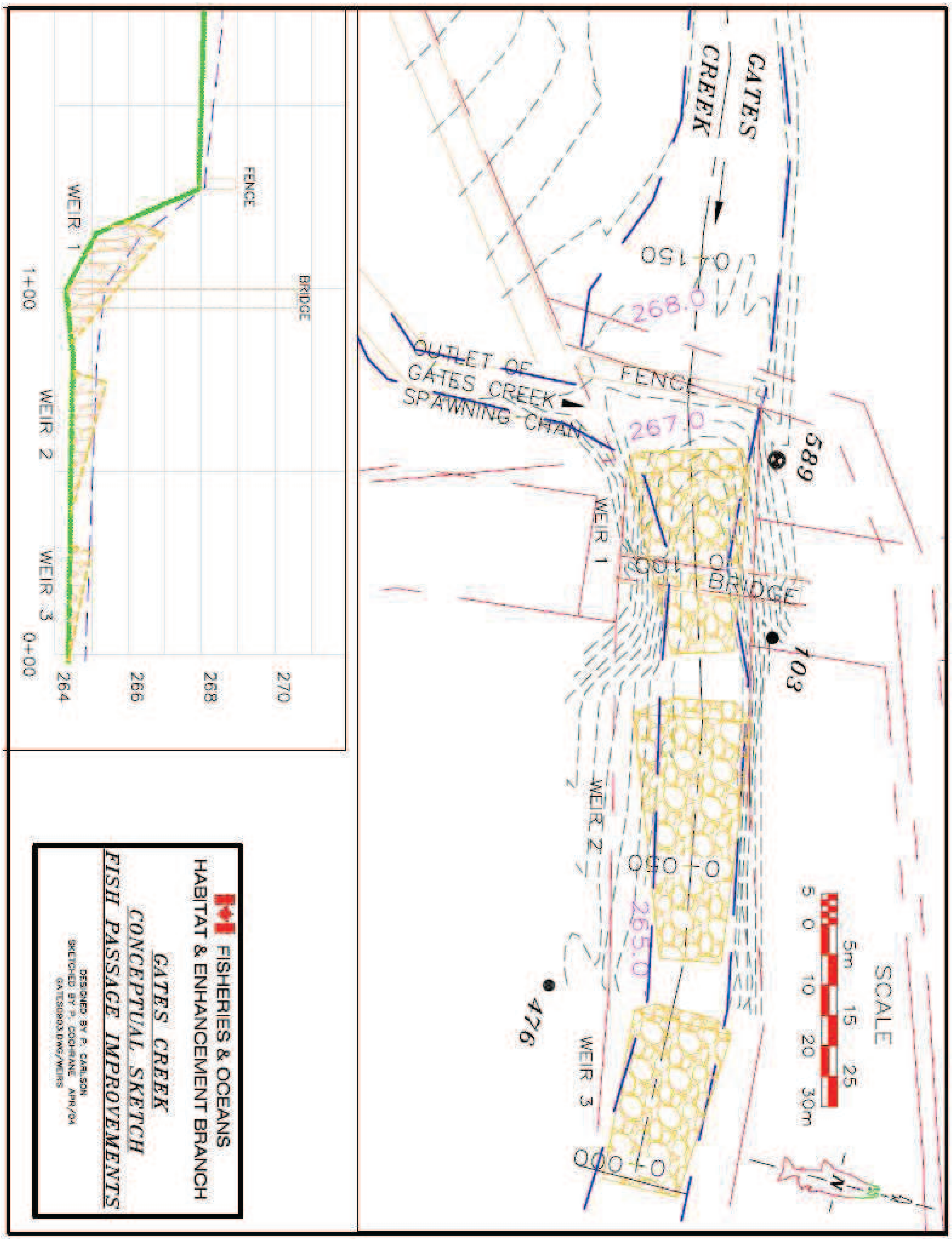

Figure 8. Conceptual sketch of Gates Creek rock weirs to improve migratory fish passage.

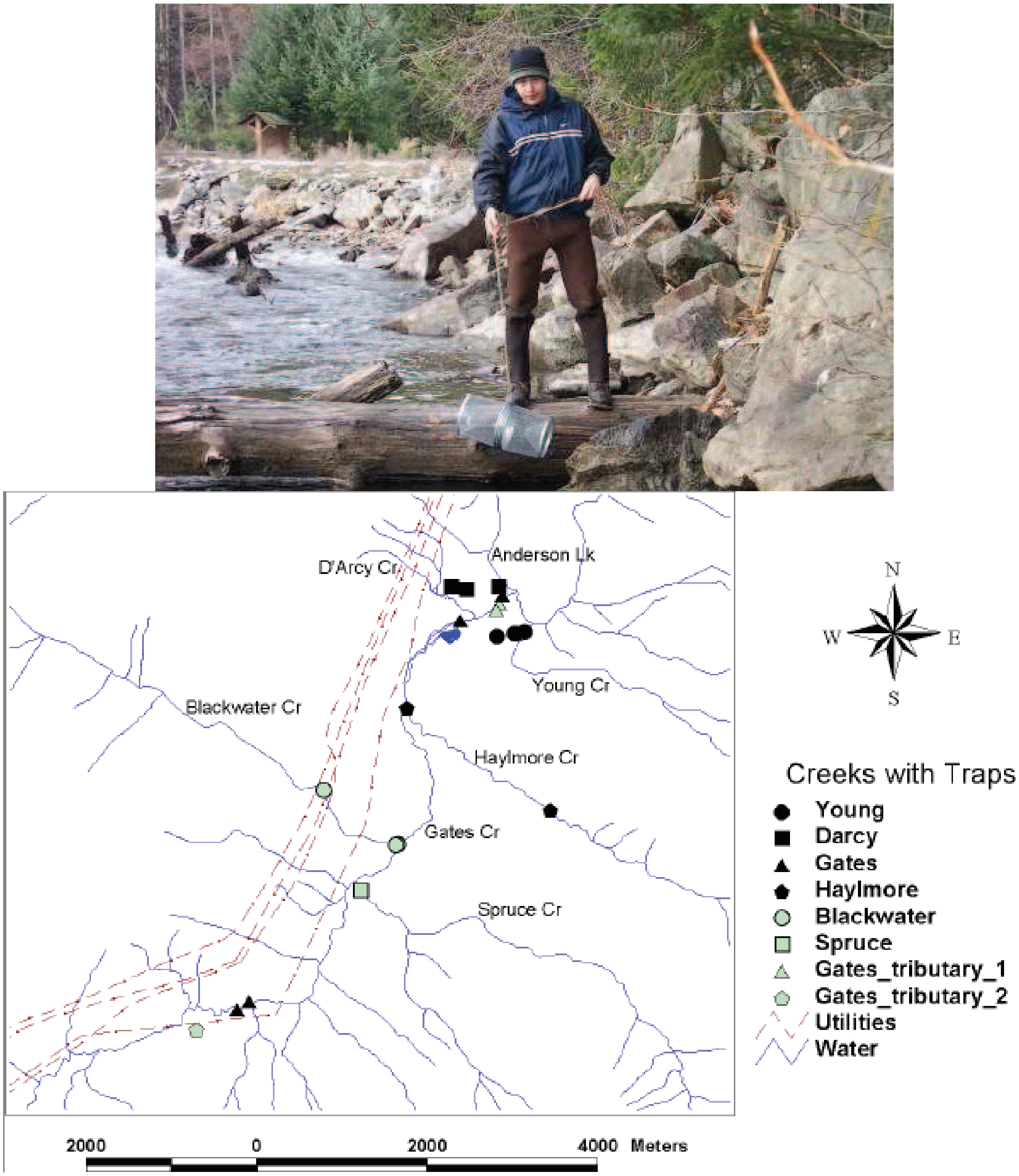

Figure 9. Sites sampled by Thevarge (2004) using minnow traps.

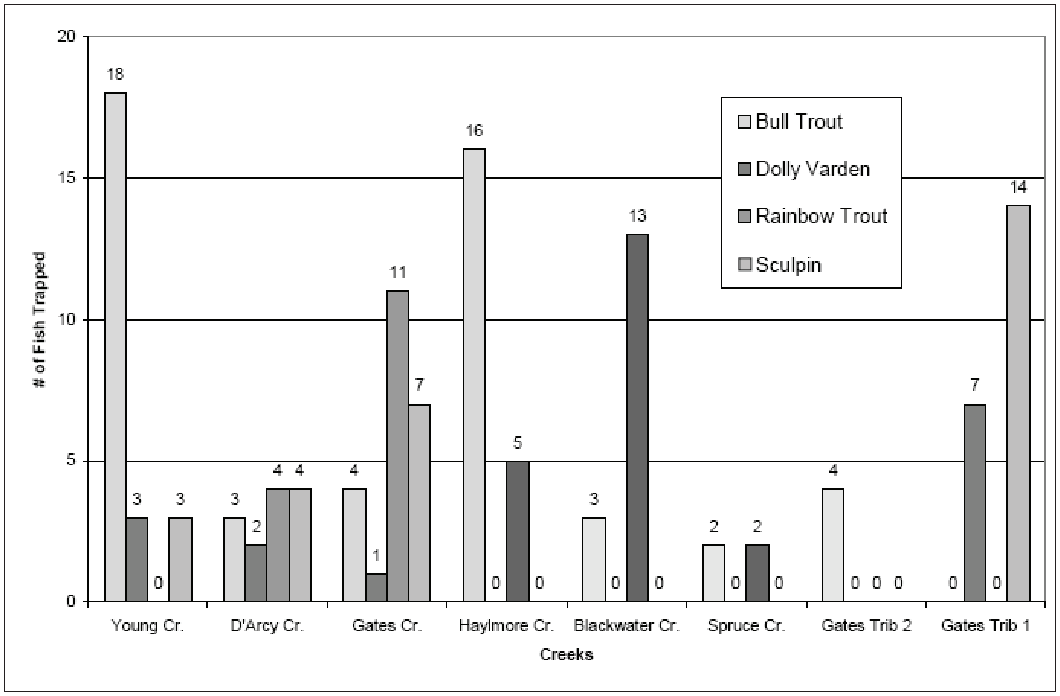

Figure 10. The total number of fish trapped for each species, except coho, in the ten days of trapping in 2003/2004.

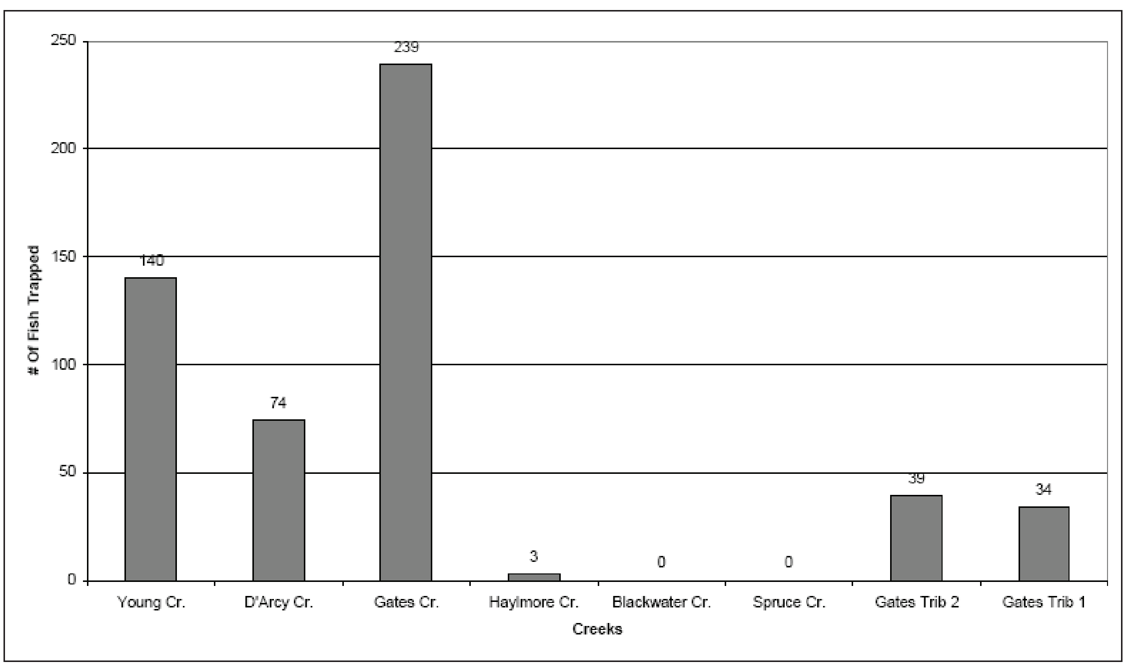

Figure 11. The total number of coho trapped in the ten days of trapping in 2003/2004.

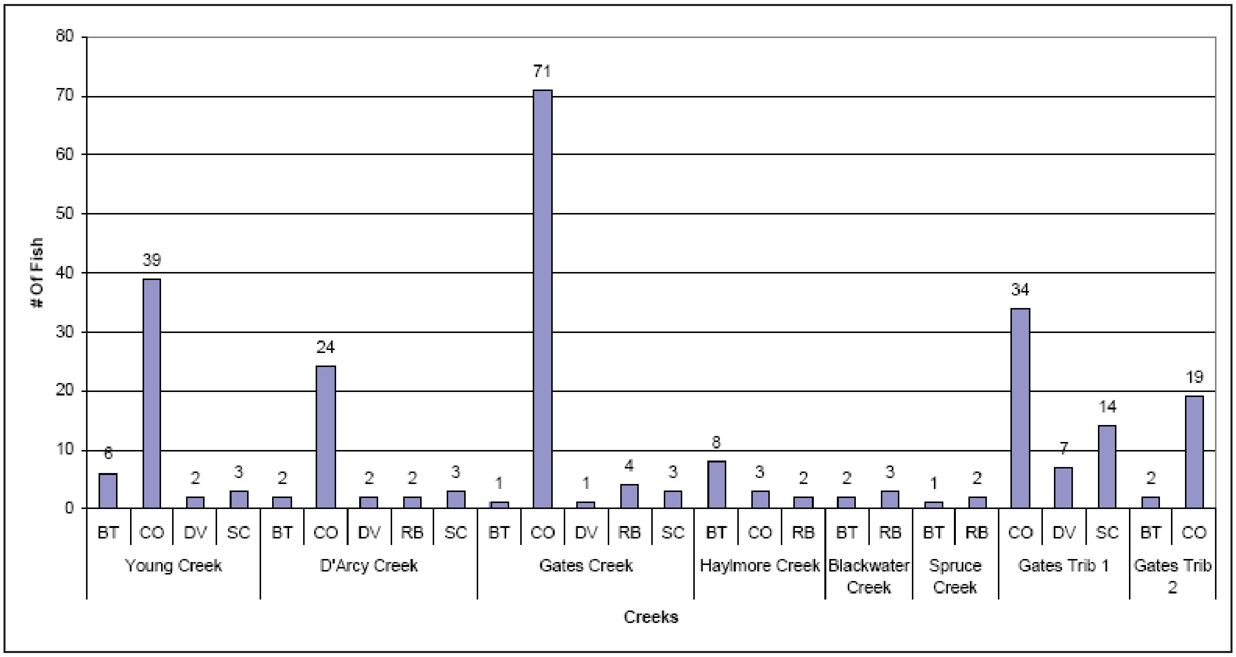

Figure 12. The highest number of juvenile fish trapped for each species in one day at each creek in 2003/2004.

These catch results indicate the predominance of coho in the salmonid fish community.

Sockeye Salmon

Gates Creek supports an important sockeye run which is part of the Fraser River Early Summer run timing group, returning to Gates Creek starting in early August. The largest component of the run spawns in the Gates Creek spawning channel (Figure 13) which was originally built by the International Pacific Salmon Fisheries Commission in 1968. The channel is presently operated by N'Quatqua and the Department of Fisheries and Oceans. Accurate counts of the fish are obtained as they enter the channel.

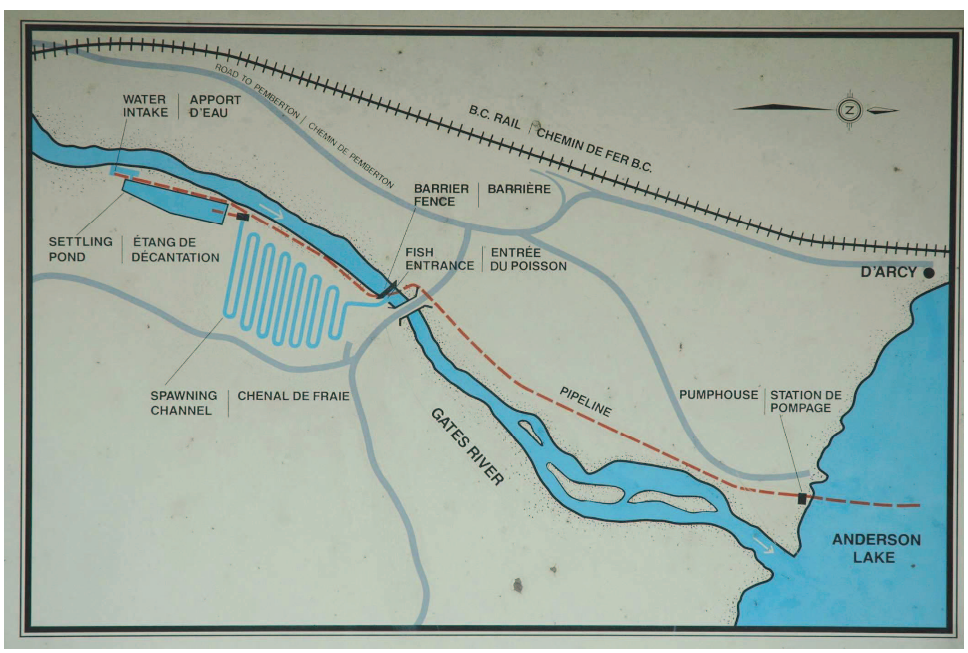

Figure 13. Gates Creek Spawning Channel. Upper: airphoto from the early 1970's. Lower: bird's eye view.

Figure 14 shows a time series of sockeye escapements to the Gates Creek system (bars represent total escapement to both the channel and the creek). The channel has a capacity for about 35,000 sockeye; escapements above this number are diverted to the creek upstream of the channel (Figure 15).

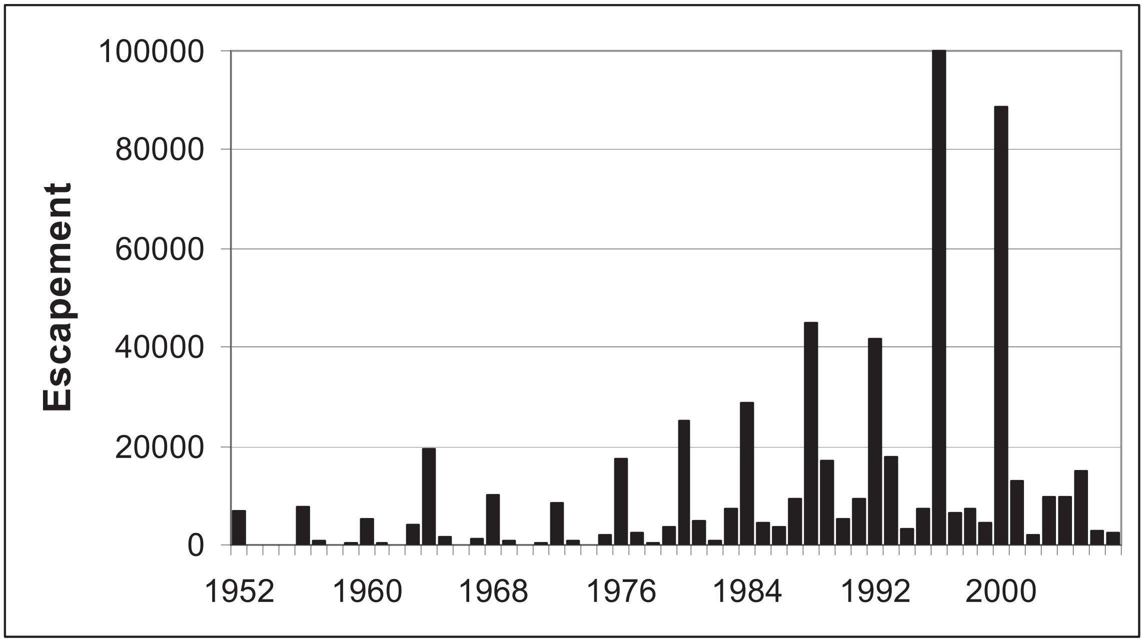

Figure 14. Time series of sockeye escapements to Gates Creek.

Hume (DFO, personal communication) has estimated that prior to the Hell's Gate slide, dominant cycle returns to Gates Creek were on the order of 150,000 spawners (Figure 15). This indicates that there is significant upscale production potential for sockeye at Gates.

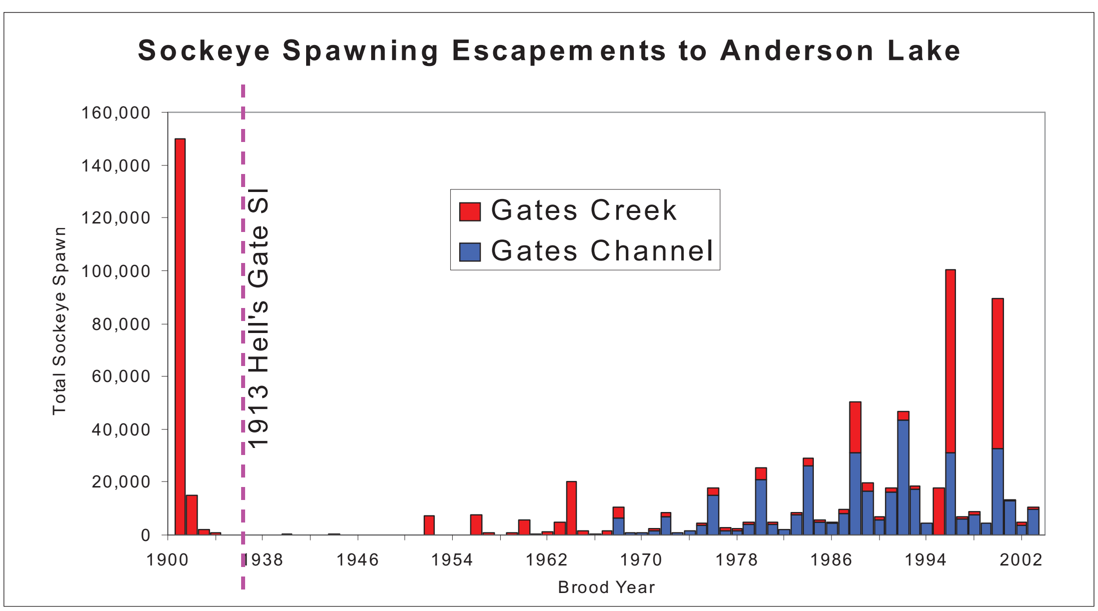

Figure 15. Sockeye escapements showing distribution in the channel and creek.

During 2008 and 2009, Northern Statimc Fisheries, N'Quatqua and DFO undertook a gravel replacement project for the channel. Over the years, the existing gravel migrated to the bottom of the channel, and sockeye were spawning adjacent to large cobbles and boulders. In addition, the channel was re-graded to improve water flows. Figure 16 shows photos from this project.

Figure 16. Methods utilized for spawning gravel replacement.

The following field observations were made by DFO in 2008:

- The channel itself in general looks in good repair.
- The gravel in the channel appears to have more of the 4-6 inch size stones than considered optimum and this may be reducing the ability of female salmon to excavate their redds during spawning.
- The gradient over the gravel legs in each channel is extremely low partially due to original design and the suspected raising of the cobble weirs during maintenance over the years.
- This has led to a reduced water velocity and almost no gradient over the gravel bed which may be the primary cause of lower incubation survival in recent years. Sedimentation may not as large a factor as originally suspected.
- It is recommended that the 4 inch and above gravel be removed if possible.
- Supplementary gravel in the 1/2 to 2 inch range should be added to bring the average gravel size down. This should make it easier for the spawners to move the gravel thereby promoting good egg deposition and a cleaning of the intra gravel environment by the fish themselves. As a large percentage of the present gravel appears somewhat angular, any new material should be more rounded in nature.
- Remove all the cobble weirs and re-grade the channel to increase the actual slope of the gravel bed thereby improving intragravel water exchange. The slope is expected to increase to 0.18 % by these actions. It appears to be close to 0.0% at the moment and may only be functioning due to passive water exchange in the gravel or from down welling due to perforations in the liner.
- The channel bed may need to be roughed up in first year to ensure adequate water depth until the fish re-profile the bed.
- It may be possible to lower the fry enumeration weir up to 0.3 m to increase head available for the spawning channel upstream, and a new fry sampler could be installed (based on the current Weaver Creek design) which is more effective, requires less driving head and has lower maintenance requirements.
- The adult fence weir at the lower end needs to allow fish to be directed over to the right bank and a proper migration channel provided so that all life stages of fish can migrate to the creek upstream as they wish.

- In the future it is suggested that a minimum of 30% of the sockeye salmon return each year be allowed to migrate upstream to spawn in the natural grounds in Gates Creek. One practical way this may be accomplished would be to open the river fence for one day every three throughout the run and closing the channel on that day to promote upstream migration.

- The settlement pond looks in good repair but may benefit from excavation to remove accumulated sediment in the future (this does not seem to be required at the moment).

- The intake structure is failing and is a major impediment for upstream migrating fish of all species and sizes and may be a complete barrier to fish below 50 cm or less. It requires immediate attention and a long term plan to rehabilitate the weir and river channel downstream to make it more conducive to fish passage.

- All cobble weirs up the top of leg 8 should be removed, the gravel scarified and sloped and the large stone armouring the top layer either partially removed or mixed in as able. This is a temporary fix until the smaller gravel supplementation can occur for each channel leg.

- A temporary fish fence should be placed at the top of leg 8 to keep spawners to the more productive lower half of the channel.

- The cobble weirs above leg 8 could be temporarily raised to make the channel deeper and slower and thereby a more effective settlement area for fine sediments.

- A plan should put in place to allow 30% of the return upstream into Gates Creek (past the fish fence) this year.

Many but not all of these improvements were implemented in 2008-2009.

During November 2008, the sockeye egg survival in the channel was measured to evaluate the effectiveness of the newly deposited gravel. Table 1 summarizes the results. In the new gravel (samples 1-8) egg survival was 79%. In the old gravel (samples 9-14) egg survival averaged 33%. This represents a 2.4 fold improvement in egg survival following gravel treatment and grading.

Table 1. Gates Creek Spawning Channel - Hydraulic Redd Sampling - November 27, 2008.

Samples re-ordered and listed in sequence from bottom of channel to top
Majority of dead eggs were eyed from all locations
Channel legs numbered from top to bottom (1 to 14) as per original drawing

Sample	Live Eggs	Live Alevins	Total Live	Dead Eggs	Total sample	% Survival	Leg Survival	Location
1	18	1	19	23	42	45.2		Leg 14 (bottom)
2	206	1	207	8	215	96.3		"
3	102	0	102	4	106	96.2		"
4	269	10	279	5	284	98.2	84.0	"
5	15	0	15	26	41	36.6		Leg 9
6	148	5	153	69	222	68.9		"
7	128	2	130	6	136	95.6		"
8	114	0	114	11	125	91.2	73.1	"
9	85	0	85	130	215	39.5		Leg 3
10	124	0	124	192	316	39.2		"
11	148	2	150	97	247	60.7		"
12	152	2	154	354	508	30.3	42.5	"
13	40	0	40	216	256	15.6		Leg 2
14	49	0	49	332	381	12.9	14.2	"

Gates Creek sockeye experience juvenile and adult mortality associated with smolt entrainment into the Seton Power Canal and adult migration delays at the Powerhouse and at the fish ladder at the Seton Dam. The smolt mortality is being mitigated at present by nightly shut downs of the Seton generator during smolt migration periods (Levy and Sneep 2009). Powerhouse tailrace delays occur when the sockeye's ability to detect Seton home stream water is compromised by the presence of high volumes of diverted Bridge River water at the powerhouse. This impact is partially mitigated by altering the flow discharge of the Cayoosh Diversion channel that was constructed to manipulate flow mixtures. Lastly, a UBC team has been studying Gates Creek sockeye passage at the Dam and has documented high mortalities of adult sockeye. Further description of these 3 impacts on Gates Creek sockeye is presented below.

Sockeye Smolt Mortality and Entrainment into the Seton Generator

The diagram below shows the location of Seton Dam and the diversion canal leading to the powerhouse.

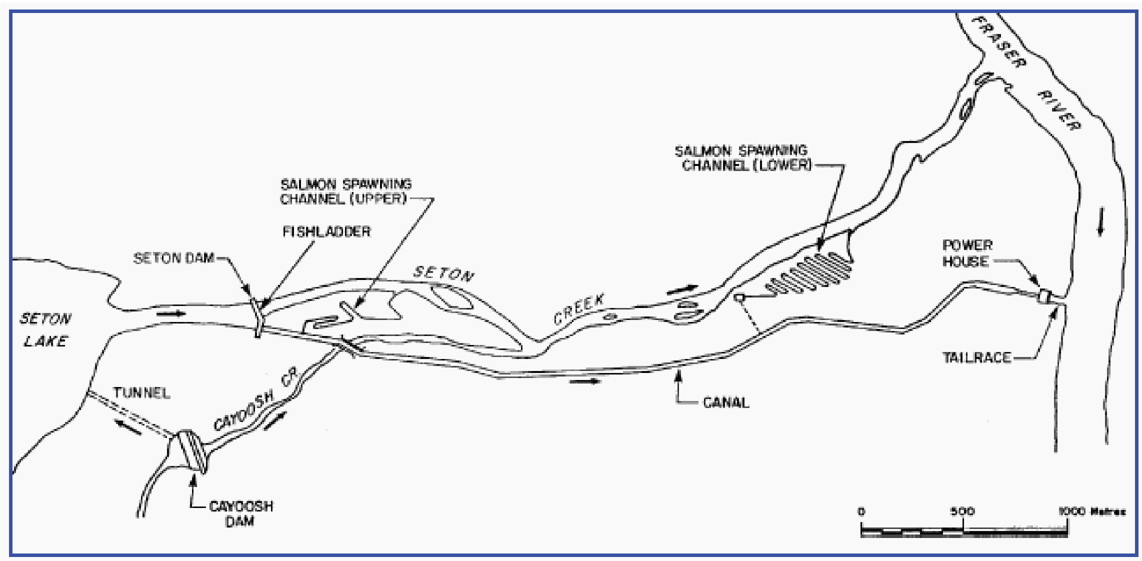

Figure 17. Seton Power facilities and adult salmon mitigation works. Source: Hirst (1991).

The fish ladder around Seton Dam is located adjacent to the fish water release at the dam headwaters. The fish ladder is a vertical slot pool ladder, which allows for operation through a large range of water flows. The fish swim through the vertical slots and rest in the pools between.

Depending on the operation of the Seton facility, salmon smolts can migrate downstream of Seton Dam via one of five exit routes (Figure 18): power canal/turbine, fish ladder, fishwater release, siphon spillway, and radial gate spillway. The entrainment rate is influenced by flow routing; smolts tend to concentrate in the high power canal flow discharges. Previous studies suggest that over 94% of the smolts are entrained into the power canal and subject to mortality when they pass through the generating station.

Groves and Higgins (1995) identified the spillways, fish water release gate, and the fish ladder as “bypass facilities” wherein reasonably safe fish passage occurs. During their study, flows were approximately 102 m^3/s, 0.85 m^3/s, and 5.7 m^3/s in the power canal, the fish ladder and fishwater release, respectively (Groves and Higgins 1995). If one assumes that smolts are routed through the Seton facility in proportion with discharge, this implies that 94% of the fish are entrained into the power canal and exposed to turbine mortality.

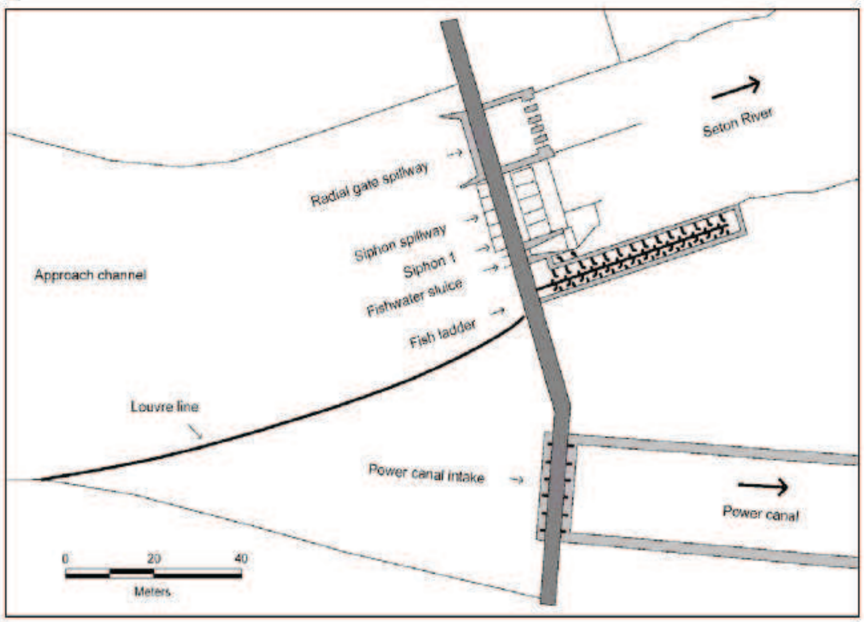

Figure 18. Upper: Seton Dam nearing completion about 1955 (from Roos 1991). Lower: Bird's-eye view of power canal and by-pass structures. Note: louver not functional since 2001. From RL&L (1999).

Following power canal entrainment, sockeye smolt mortality rate is estimated as 17%. This mortality rate estimate is based on previous IPSFC studies carried out at the Ruskin plant on the Stave River as well as within the Seton facility (Groves and Higgins 1995). The 17% estimate includes direct mortalities as well as latent mortality from injuries, cumulative stresses, disease and predation. While many different methods have been tested to mitigate smolt mortality, operational flow modifications appear to have the greatest potential to provide the most effective method (Groves and Higgins 1995). The approach involves scheduling annual or daily turbine shutdowns to overlap with the greatest densities of migrant smolts, thereby minimizing smolt entrainment into the power canal.

The entrainment rate of sockeye smolts was measured via mark-recapture experiments in 2008 (Levy et al. 2008) which indicated that 84% of smolts were diverted into the power canal. In spite of the high diversion rate, the nightly plant shutdown strategy appears to be effective at keeping the mortality rate below the 5% target level (Levy and Sneep 2009).

Adult Sockeye Tailrace Delay

The impacts of the Seton Dam on adult sockeye stem from their attraction to Seton waters at the powerhouse tailrace. Seton waters pass via the diversion canal and the powerhouse into the tailrace. These homestream waters attract fish into the tailrace which delays or prevents their migration into the Seton River. Sockeye frequently migrated from the tailrace into the lower Seton River, and then returned to the tailrace (Fretwell 1979). This "tailrace delay" was investigated during the 1970's and 1980's. In addition to the migration delay, salmon can be injured or killed by attempting to swim into the draft tube (Rowland 1981).

During the 1970's, despite a minimum discharge of 400 cfs at Seton Dam and tri-weekly powerhouse shutdowns of not less than 3 hours duration, a large percentage of adult sockeye (up to 65%) did not reach their spawning grounds (Anon. 1976). A continuous Seton spillway discharge of 1000 cfs in the Seton River reduced, but did not eliminate, the tailrace delay and loss of sockeye. Experiments were undertaken to examine fish mortality under different power loads (high numbers of fish were killed under low loads after being struck by the turbine runner).

By inserting radio tags into sockeye, Fretwell (1989) experimentally analyzed the effect of powerhouse shutdowns and spillway discharges on fish migration success. Radio-tagged sockeye failed to migrate upstream into the Seton River after encountering a higher concentration of homestream water in the powerhouse tailrace. It was found that sockeye failed to migrate upstream in Seton Creek unless the proportion of homestream water (Seton Lake outflow) was increased to at least 80% for summer-run fish (Gates Creek sockeye) and 90% for fall-run fish (Portage River sockeye).

These required concentrations are obtained by diverting Cayoosh Creek water to Seton Lake, and increasing the spill discharge at Seton Dam. Figure 19 shows how the Cayoosh Creek diversion partially mitigates the tailrace delay. The Post 1979 flow patterns result in similar homestream water concentrations at the tailrace and the Seton River. This double stream of homestream water delays migrating adults, but the duration of the delay is unknown.

In practice, BC Hydro do a good job of delivering the 90% dilution ratio for Portage River sockeye, but a poor job of delivering the 80% dilution ratio for Gates Creek sockeye. This is due to the “flashiness” of Cayoosh Creek during the time of the Gates Creek sockeye migration. Figure 20 illustrates a time series of annual dilution ratios before and after (post -1979) the installation of the Cayoosh Creek diversion. Following construction of the Cayoosh Diversion, dilution ratios for Gates Creek sockeye were exceeded during 10 out of 16 years.

Other species apart from sockeye, e.g. chinook, also experience tailrace delay, but no studies have been undertaken to determine the duration of this migratory delay. Additionally, Bridge River salmon populations are also attracted to the Seton River and the Seton tailrace since the water at these locations is largely diverted Bridge River water.

Gates Creek Sockeye Passage at the Seton Dam

Roscoe and Hinch (2007) undertook research were to quantify adult sockeye mortality along the migratory route in the Seton-Anderson watershed, evaluate fishway passage efficiency, assess the impact of the fishway on migration success and identify needs for management experiments and future research. The following description of the research is taken directly, with permission, from the Executive Summary of the Final Report:

> Telemetry was used to track migrations and determine fish fate. Results were related to environmental conditions encountered (e.g. discharge, temperatures) and physiological condition (stress or maturation levels measured from non-lethal biopsy). Eighty-seven Gates Creek sockeye salmon were captured by dip net from the Seton Dam Fishway, non-lethally biopsied, tagged with a telemetry transmitter and released either upstream or downstream of the dam.
>
> Blood plasma cortisol, lactate, glucose, and ion concentrations were similar to values from the literature for healthy migrating sockeye salmon suggesting that fish were not physiologically stressed or exhausted after fishway ascent. Successful migrants were not physiologically different

from failed migrants, and physiological condition was not strongly correlated with migration behaviour.

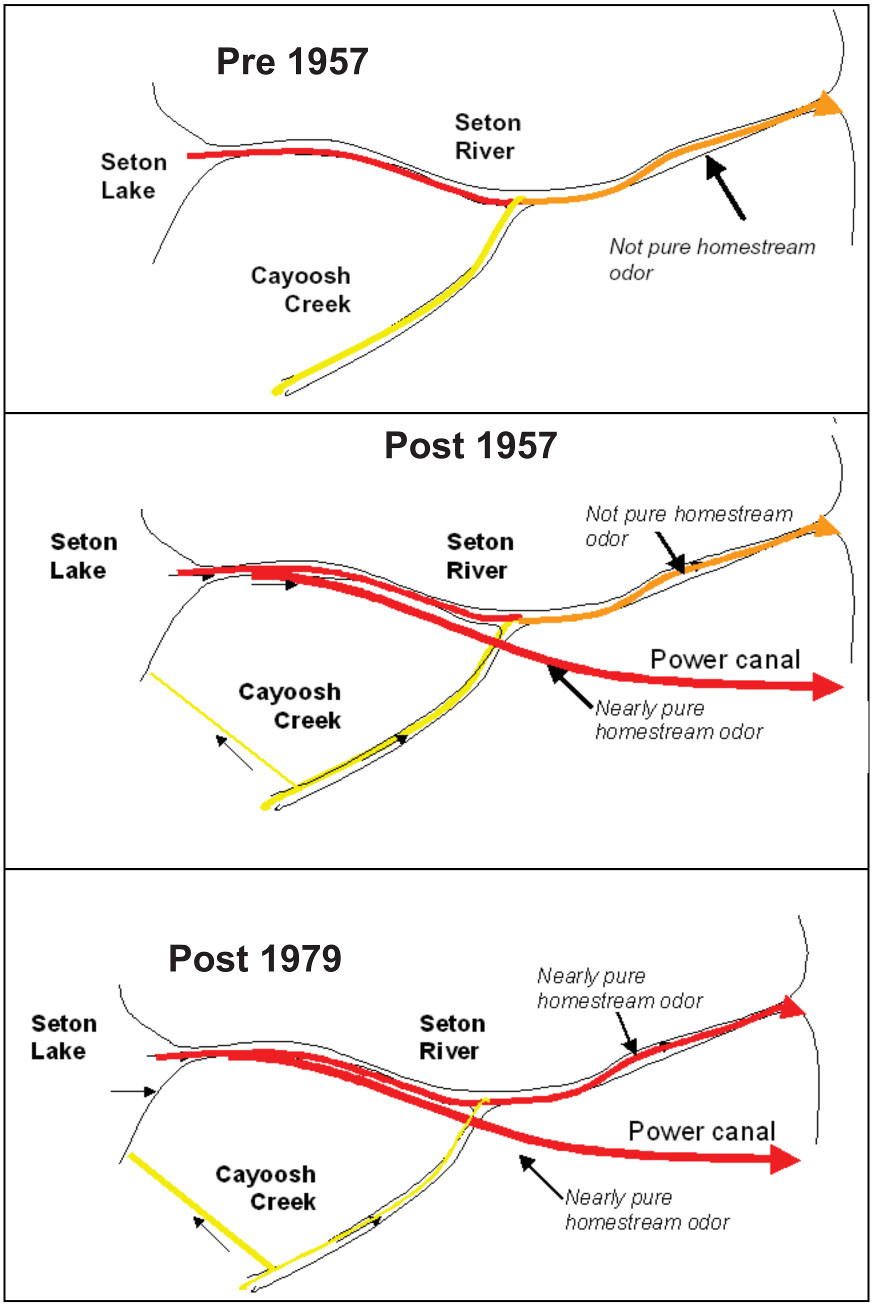

Figure 19. Schematic diagram showing how the Cayoosh Creek diversion partially mitigates salmon tailrace delay by equalizing homestream odor concentrations in the Seton power canal and the Seton River.
Source: P. Higgins, BC Hydro.

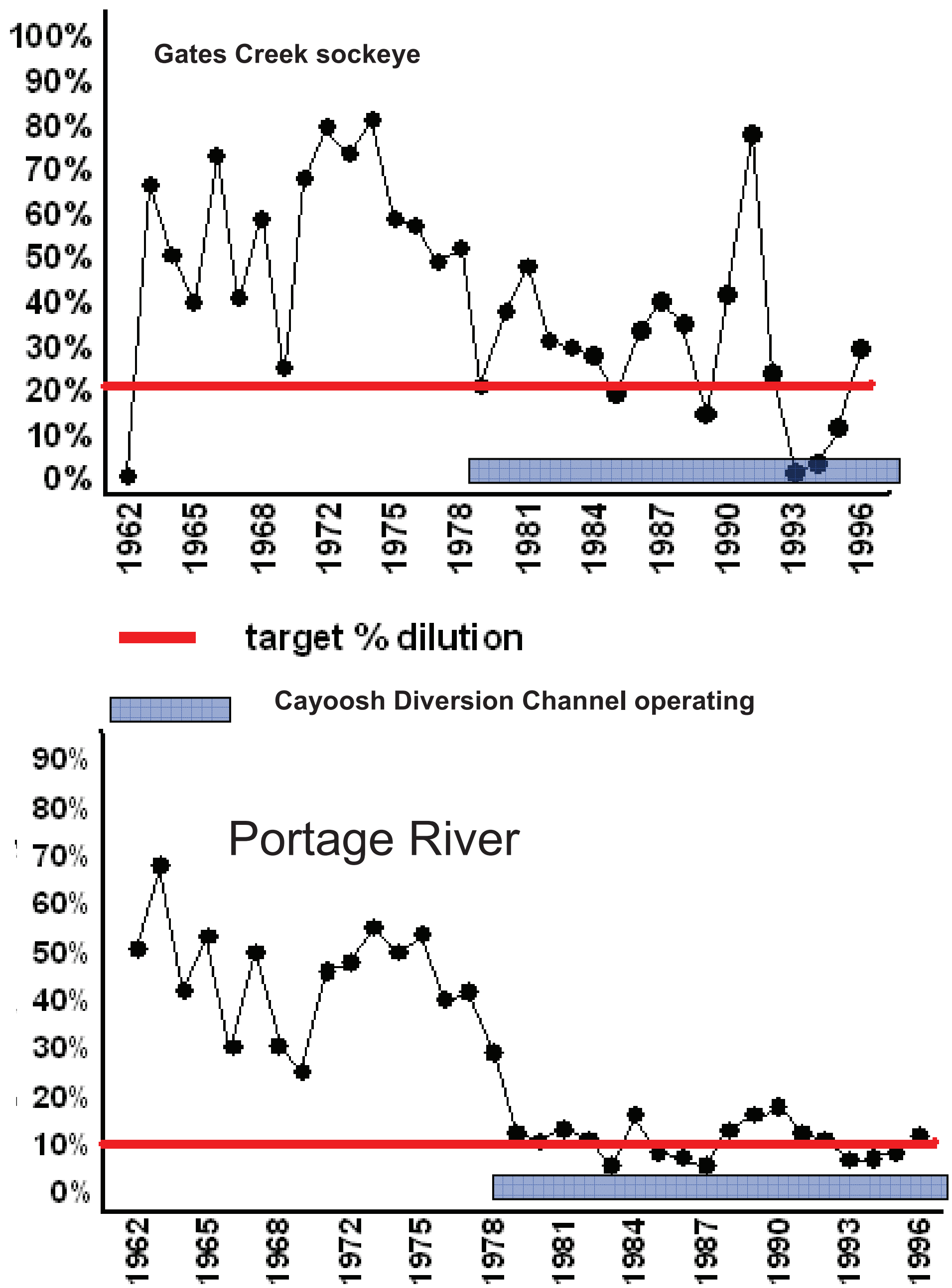

Figure 20. Percentage of Cayoosh Creek water in Seton River water during adult sockeye migrations. Source: P. Higgins, BC Hydro.

These results suggest that sockeye released downstream of the dam were in good condition to re-ascend the fishway and that failure was probably not related to physiological stress or physical exhaustion.

Total loss of migrating sockeye between releases sites downstream of the dam and spawning grounds was exceptionally high (52%). Over half of this loss (32%) occurred in the 4.4 km reach between the Fraser River and the top of the fishway. The remaining mortality (20%) occurred between the outlet of Seton Lake and spawning grounds. Of fish released downstream of the dam, 71% of 17 males and 40% of 38 females reached spawning grounds, suggesting that females suffer higher mortality than males. These findings have serious implications for conservation since spawning success of a population depends largely on females.

Five sockeye that fell back from the Seton dam or lower Seton River were detected in the powerhouse tailrace on the Fraser River. This suggests that the tailrace may attract and delay sockeye even under the current Seton River dilution guidelines aimed at reducing this problem. The cause of tailrace attraction is unknown but it may involve attraction to homestream water, alternate route seeking behaviour by fallbacks, or utilization of a thermal refuge.

Twenty percent of fish failed to pass the dam and fishway. This failure rate was believed to be a conservative estimate because the fish had prior experience in entering the fishway. Failure at the fishway was related to locating the entrance (i.e. attraction) and not ascent of the fishway itself. These findings were consistent with our previous study of fishway passage at the Seton dam in 2005 (Pon et al. 2006).

Pooling results from 2005 and 2007 revealed that fishway attraction efficiency varied with spill discharge from the dam (range: 11 to 60 m^3/s). Attraction was the lowest (40%) and average delay (± SE) the longest (44.2 ± 20.9 hrs) during the highest discharge level of 60 m^3/s although sample size was small (n=5 fish). However, when considering all discharge levels studied, there was not a simple relationship between discharge levels and levels of attraction. This was also identified by Pon (2008).

Of fish that passed the dam and entered Seton and Anderson lakes, total in-lake mortality was 33% for fish released at the powerhouse tailrace and 19% for fish released in the lower Seton River, compared to only 7% of fish released upstream of the dam. The cause of in-lake mortality is not clear but it was probably unrelated to stress or energetic costs incurred re-ascending the fishway. At least one tagged sockeye was captured by fisheries and it is possible that other fish that disappeared upstream of the dam were also harvested.

Temperature loggers recovered from tagged sockeye and fixed stations indicated that fish generally did not encounter extremely stressful temperatures. Temperatures in the Seton River were cool (12-15^{o}C), and sockeye did not delay in cooler waters in Cayoosh Creek (11-12^{o}C), but could have utilized the powerhouse tailrace as a thermal refuge. Temperature exposure in Anderson Lake was highly variable and many sockeye utilized cool water refugia in the hypolimnion.

Temporary blockage or obstruction in the fishway could have serious consequences for populations of migrating adult sockeye. We found that a small number of tagged sockeye fell back downstream when the upstream exit of the fishway was blocked during sampling and these fish generally did not re-ascend. Therefore, we recommend that the fishway is monitored and maintained frequently (daily) during the migration season so that blockages are cleared immediately. Furthermore, any new modifications to the fishway, such as fish enumeration devices, should be carefully evaluated in terms of their effects on passage.

When possible, managers should strive to minimize relatively high discharge levels (e.g. ~ 60 m^3/s) in the Seton River in order to facilitate sockeye passage. Management experiments which involve manipulating spill discharge in the Seton River are needed to better define the relationship between discharge level and passage success.

Based on the combined results from our 2005 and 2007 studies, we conclude that failure to ascend the dam was primarily associated with locating the fishway entrance and not with passage of the fishway itself. Hydraulic conditions near the dam face vary widely with changes in discharge and this will affect orientation cues for salmon. As was recently suggested by Pon (2008), management experiments are needed which alter hydraulic conditions in the tailrace of Seton dam at a given discharge level (via different locales of water release from the various sluices), and assess delay and fishway attraction. Studies should also examine whether there is a threshold level of delay that causes salmon to fallback or seek alternate routes, reducing the probability of successful migration.

The estimate of passage failure at the fishway should be considered an underestimate. Future studies should sample fish that are 'fishway-naïve' by catching sockeye in the lower Seton River. This was attempted with tangle and dip nets in 2007 but fish numbers were too low for these techniques to be effective and all indications are that these sockeye runs will not be large in the near future so this sampling problem will persist. A fish weir with trap boxes in the lower Seton River was recommended, to be installed and operated during sockeye spawning migrations, during years when fish need to be captured for telemetry or biosampling to assess fishway performance and migration mortality.

Gwenish

Anderson Lake and Seton Lake provide habitat for a unique strain of kokanee known as gwenish. The fish are black in colour (Figure 21) and utilize deep (20-70 m) spawning areas. Spawning periods extend throughout November in Seton Lake, and throughout January in Anderson Lake. Historically, gwenish were extremely numerous. Local residents report that dead gwenish used to be piled high and wide along the beaches of Seton and Anderson Lakes.

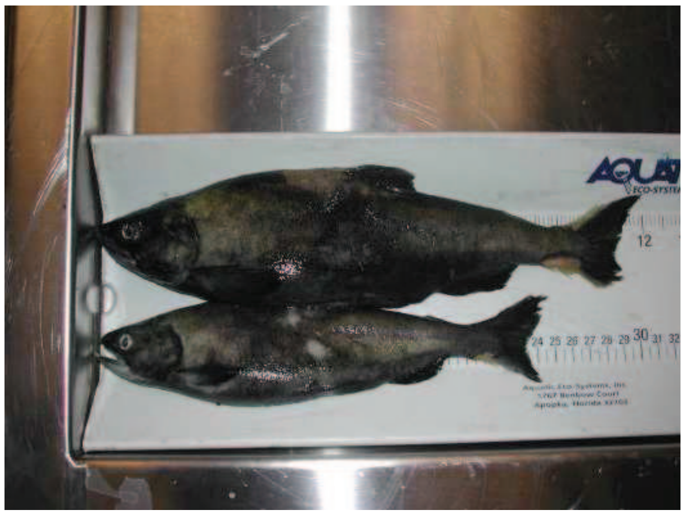

Figure 21. Gwenish specimens from Anderson Lake.

Morris and Caverly (2004) identified 2 gwenish spawning areas in both of Seton and Anderson Lakes. Gwenish spawners in Anderson Lake are older (4+ years old) than those in Seton Lake (2+ years old). Anderson Lake gwenish are also larger and heavier fish. Stables (2004) surveyed gwenish spawning areas using hydroacoustics and an underwater video camera and found that highest densities of spawners were found at 30-60 m depths on gravel fans beside talus slopes along the lake shore (Figure 22).

BC WLAP previously carried out an investigation for several years (Morris et al. 2003a, 2003b, 2004) called the ***Seton and Anderson Lakes Kokanee Assessment***, that addressed four objectives:

1. Assess and document key kokanee spawning sites in Seton and Anderson Lakes.
2. Implement a systematic, standard procedure for enumerating kokanee with the intent of establishing key sites for index of abundance estimates.
3. Determine kokanee population estimates for both lakes.
4. Develop a kokanee conservation plan for both lakes.

The project was terminated prematurely and the objectives were only partially completed.

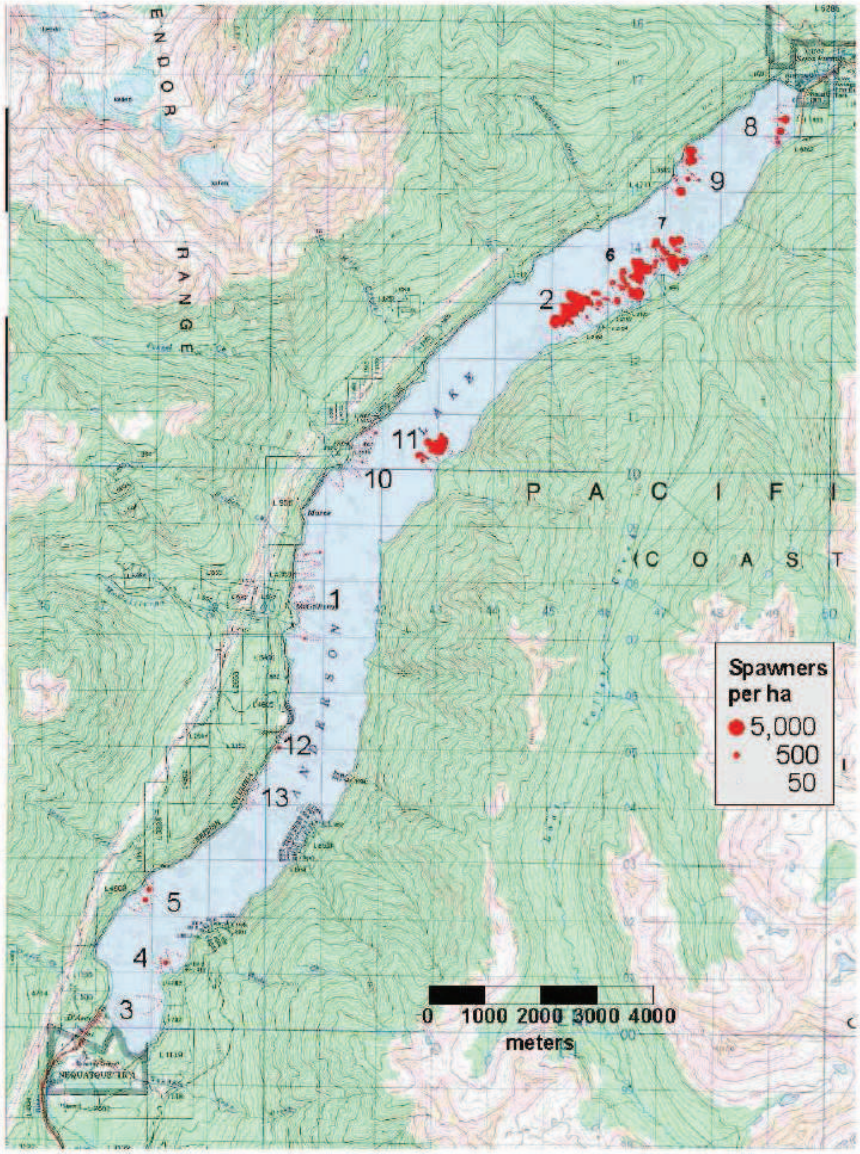

Figure 22. Gwenish spawning areas (red circles) in Anderson Lake. Source: Stables (2004).

Hydroacoustic surveys of Anderson Lake were undertaken by DFO between 2000 – 2003 to develop preliminary population estimates. An example of the vertical distribution of gwenish in the water column, as reflected on an echogram, is shown in Figure 23.

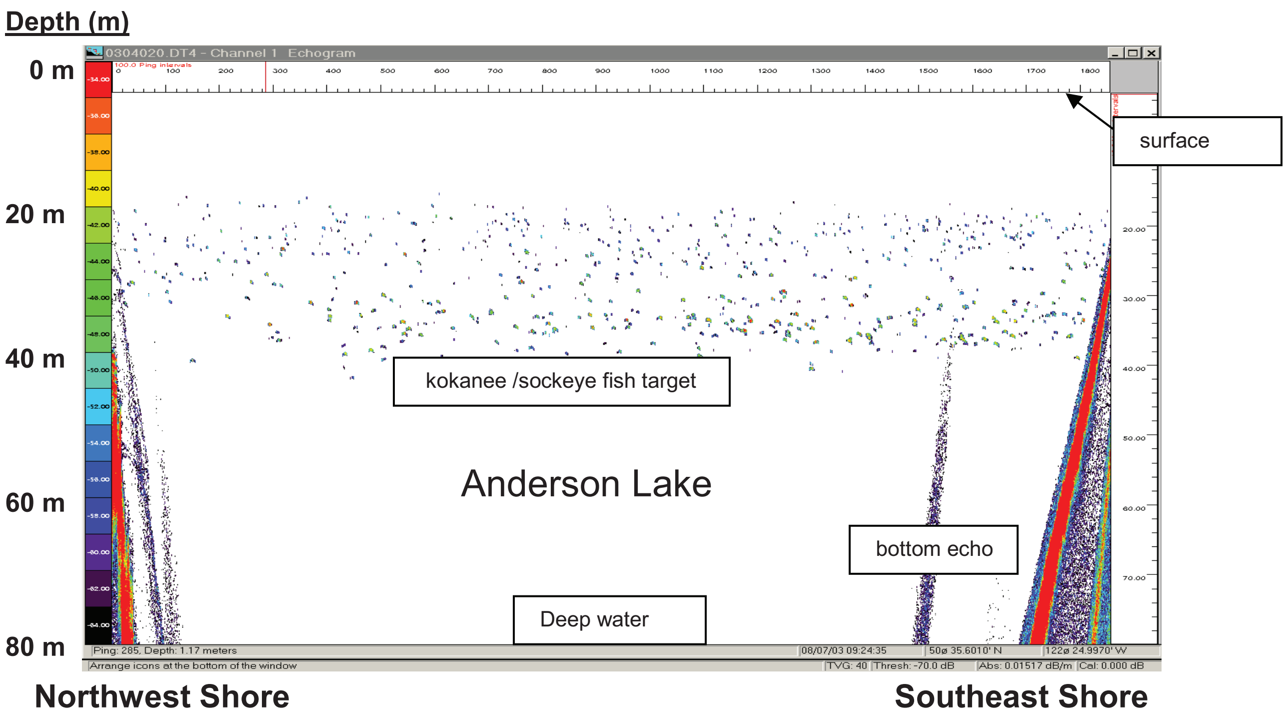

Figure 23. Echogram from Anderson Lake.Source: J. Hume, DFO.

Coho Salmon

As documented by previous investigators, coho predominate in the salmon community of Gates Creek. Recorded escapements have varied from a few hundred to 1700 spawners. Spawning takes place in November and December. Coho visual escapement data for Gates Creek collected by DFO between 1995 and 2003 (Figure 24) indicate some very low escapement years with less than 100 spawners in some years. These low numbers are probably artifacts due to poor surveying conditions.

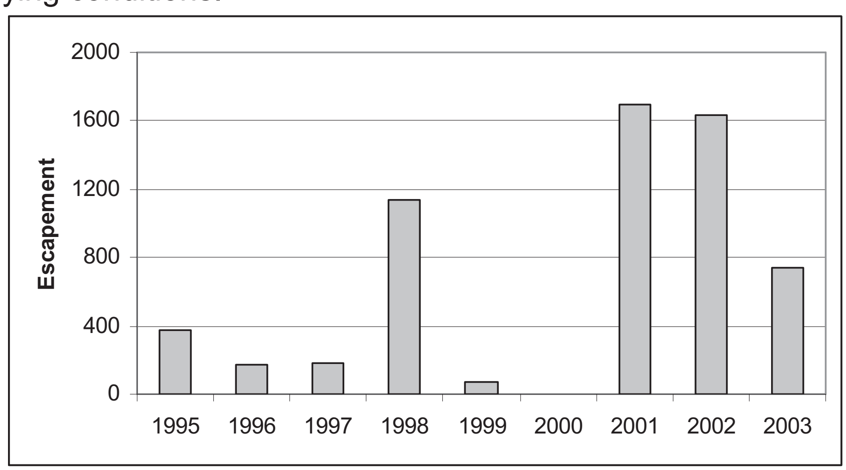

Figure 24. Coho escapement into Gates Creek between 1995 – 2003. Source:DFO

Chinook Salmon

In addition to the fish species encountered by Matthew and Stewart (1987), a juvenile Chinook was captured by Creekside (2001) in a minnow trap in the lower section of Gates Creek. It is unknown whether Chinook at Gates are strays from another system or whether there is a spawning population at present. DFO and BC Hydro formerly planted eyed Chinook eggs from Tyaughton Creek into Gates before the formation of the Carpenter Reservoir. In addition to juveniles, occasional Chinook adults are captured at the Gates spawning channel, most recently in 2008 (1 animal).

The Bridge-Coastal Fish and Wildlife Restoration Program- STRATEGIC PLAN- Watershed Plans. December 2000, documents the Chinook transplant into Gates Creek:

> *In 1948 as hydro construction began, one of the first projects of the Fish Culture Branch was a salvage operation on the Upper Bridge Chinook run that began to collect below the Mission diversion dam at the end of July (Neilson and Shepherd 1983). Broodstock salvages continued until 1952 with eggs planted in Gates, Portage and Yalakom rivers, but subsequent assessments indicated dwindling Chinook returns to these systems.*

Conclusions and Recommendations

1. Gates Creek is a very important salmon producer in view of the steep-sided topography around Seton and Anderson Lakes. There are only two major salmon producing tributaries in the watershed: Portage and Gates.

2. Gates Creek sockeye production has been compromised historically for various reasons described in the report. They include inadequately-sized spawning gravels in the spawning channel, smolt entrainment into the Seton Powerhouse, and migration problems associated with tailrace delay and fish passage at the Seton Dam fish ladder. These problems are being presently mitigated so future production can be increased.

3. In the future a minimum of 30% of the sockeye salmon return each year should be allowed to migrate upstream to spawn in the natural grounds in Gates Creek. One practical way this may be accomplished would be to open the river fence for one day every three throughout the run and closing the channel on that day to promote upstream migration.

4. There are reports from local residents that gwenish populations have decreased compared to historical levels when they provided an important winter food source. There is a need to collect better data on gwenish via targeted research on adults and juveniles.

5. Gates Creek coho were successfully enumerated at a counting fence in 1986. It is recommended that Gates coho be annually enumerated by fence count to monitor the status of the population.

6. Chinook salmon have been captured in Gates Creek both as adults at the spawning channel (e.g. 2008) and as juveniles during fish surveys. It is recommended that a feasibility study be carried out to evaluate the suitability of Gates Creek for Chinook reintroduction.

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